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Introduction

Facing Global Realities

This book includes the findings of 2010 and 2014 comparative studies of the food safety systems of some industrialized countries entitled "Food Safety Performance World Ranking." These reports were a follow-up on the 2008 inaugural world ranking. The purpose of this book is to place that ranking in a broader context through deeper analysis and a more expansive discussion of new, developing, and future issues in food safety unaddressed by the report.

Facing Global Realities

Global food systems connect all consumers. Food unites both global hemispheres through exchanges of commodities, knowledge, and technologies. The rich, the poor, farmers, and city dwellers, all are interconnected within food systems for the simple reason that everyone needs to eat. Many rarely think about it, but these links form a reality that is becoming more apparent as forces such as globalization and technology extend and intensify.

But while food systems bring us together, they do not always do so in positive ways. Increasingly, perceptions of fear and risk cause food systems from around the world to integrate (Spiekermann, 2009).

In the context of food safety, 2003 was a notorious year for Canada. During that year, the country diagnosed its first native mad cow case, and, in response, 35 countries issued embargos against Canadian beef. For the first time, a food safety-driven issue made headlines for weeks in our country. The United States did not allow Canadian beef in their country because of fear that it would compromise the value of their own beef products in lucrative markets like Japan (Lewis and Tyshenko, 2009).

Further major food recalls—related to spinach, peppers, and sliced meat—kept agriculture and the food industry in the public eye ever since.

Food Safety, Risk Intelligence and Benchmarking, First Edition. Sylvain Charlebois.

The Maple Leaf recall, triggered by a listeria outbreak that caused the death of 22 Canadians, is undoubtedly the biggest food safety story Canada has seen (Goveia, 2010).

In 2008, a global food crisis made media headlines and brought the topic of agriculture back to the front pages. Hunger, starvation, riots, and volatile civil unrest in numerous countries for several months occurred at the same time as record-breaking profits for Maple Leaf Foods (Pechlaner, 2010).

While the triggers of food crisis in 2008 were multifaceted and incorporated some environmental factors (such as climate change, droughts, and natural fires), many of these causes were human induced. These were structural and arose from societal decisions about the roles of agriculture, food, health, and regulation. Agricultural trade liberalization, the growth of biofuels, and a preference for commercial over subsistence agriculture in developing countries are a few instances of practices that influenced the crisis.

Food systems from around the world are exposed to mounting systemic pressures. In order to feed the planet, the world's agricultural output will need to increase by more than 40% in 2030 and by 70% in 2070 (Moeller, 2010). More than half of the world's population lives in an area with only a third of the world's arable land (Kelleher, 2010). The next decade is likely to see a major shift in global agricultural production and trade, and so system interconnectivity will become more significant though trades, exchanges, and strategic involvement.

The world has already shown that it can dramatically increase its food production capacity, but the situation today is different. Unlike at any other stage in history, water supplies are becoming scarcer and, therefore, irrigation technologies will be the key for agriculture. National governments are coping with shifting climate patterns that are challenging to predict and manage. We have recently experienced extreme climates that have affected crops and livestock producers from around the world. Responses and implemented policies vary from one country to another. In addition, interest in the environment and awareness of agriculture's carbon footprint is growing. Agriculture, which historically has been exempted from new environmental policies, is expected to undergo changes in years to come. Like other industries, agriculture will have to cope with environmental constraints that are both justifiable and a new challenge.

On the innovation front, genomics has played a significant part in augmenting our capacity to grow foods. This trend started many decades ago with arrivals of new genetically engineered crop seeds and will likely continue. Previously, the approach to agriculture was a linear thought process involving three Fs: food, feed, and fiber. However, methodologies such as genomics will soon change the relationships among these and other theoretical models.

Bioinformatics made it possible to sequence the human genome, thus enabling humanity to decode the basic instructions of life. Bioinformatics, or synthetic genomics, is recognizing the limitations of DNA management as DNA can break easily and becomes difficult to manipulate (Nicholson, 2009). The rise of bioinformatics has boosted the efforts of companies, most importantly in pharmaceuticals, to search for the right drugs and vaccines for particular diseases.

Bioinformatics will likely change our lives, but many wonder if food consumers and farmers are ready for these changes. We may be able 1 day to "print" mouse hearts, or even pig skin, literally (Beachy, 2010). But most consumers and farmers do not know what the term bioinformatics means, let alone how it will affect their daily lives.

Embracing biotechnologies can be a double-edged sword. It may not increase the risks to which consumers are exposed, but it will certainly alter those risks in many ways. Most importantly, the ways in which consumers perceive products crafted by new technologies will also change.

Agriculture's newfound prosperity, founded in part on growing connections with life sciences, is here to stay. The value of farmland around the world has increased significantly over the past decade (Bi et al., 2010). Farmers have been able to leverage their position and increase capital. Investments in many agricultural sectors are rising at an incredible rate. Agricultural technology and innovative farming methods are catching the attention of many farmers who have the financial means to invest. Of course, agriculture has always played a vital part in the economic development, but times are quickly changing. Food production may actually grow faster than anticipated.

The future ultimately relies on establishing a sustainable agricultural system and the exploration of alternative food solutions that will provide for all consumers. The global farming landscape has witnessed the arrival of new countries wanting to play a role on the worldwide stage. The path to a new world order is now on the horizon, yet there is no clear outcome. All we know for now is that, because of this influx of new wealth, the Western world has fewer but more efficient farms centering on the economies of scale.

Demand for food will also see its share of seismic shifts in the near future. The world's population will likely exceed 11 billion people by 2050 (Collins, 2010). It is estimated that over a billion people will reach the middle class by 2030 (Moeller, 2010). This will add a significant pressure to already-stressed grain supplies and fragment demand for available foods. Half the world's population suffers from some form of undernourishment from a scarcity of food, protein or micronutrients, or a combination of these (Schade and Pimentel, 2010).

China, India, and other emerging markets will greatly affect any food systems' capacity to address food security. In these countries, more and more peasants are fleeing the country for a better life in large urban centers and cities. In effect, more farmers are quitting food production and becoming consumers.

Urbanization is affecting lives, policies, and most importantly, the future of food systems. We have already witnessed this phenomenon in the Western world, but it is currently spreading around the world. Over the last decade, the world also has seen large migrations of people transferring across countries and continents. In response, food distribution systems must adapt.

Food Systems

If you consider all these factors, the ever-increasing complex exchange between food supply and demand has led to a greater focus on creating shared values between agriculture and consumers. One of these values is certainly food safety, and we will address that issue later.

So what are food systems? This book applies the systems approach (Hughes et al., 2008). Understanding the meaning of food systems is essential to appreciate their complexities. If we want to understand the entirety, parts of the food industry—such as production, wholesaling, retailing, or policy—cannot be analyzed in isolation.

By contrast, the food systems approach considers two basic and related components: elements of the food system and processes that make the system function. The elements of a food system are measurable things that can be linked together. For example, grocers can be linked to primary producers and domestic food-related policies can be linked to food-related policies found abroad. Everything is interconnected or interrelated. Food processes, on the other hand, change elements from one form to another (Morris and Reed, 2007). Food systems are comprised of elements and processes, a network which we call an ecosystem.

Systems can be open or closed. An open system is one in which external elements and processes alter its structure or functions. A closed system will always operate independently. Increasingly, it is argued that food systems are becoming more open than ever before. Food systems are open systems with respect to most elements and processes. They receive influences and inputs from their physical environment and, at the same time, cycle outputs back out of the system. They are also open to outside influences such as disturbances (e.g., embargoes, technology,

trade agreements, *etc.*). Adopting a systems approach involves appreciating the scope and scale of the food industry, which is immense, complex, and difficult to simplify.

Food systems are being challenged more frequently due to the complexity of exchanges between elements, sometimes to the point at which the systems become compromised. Too often, global agrifood systems are characterized by the appearance of recurrent unwanted surprises.

In Canada, one such surprise occurred on May 20, 2003, when the country discovered its first native bovine spongiform encephalopathy (BSE) case, popularly known as mad cow disease. In response, many questioned the safety of our food chain. The Canadian Food Inspection Agency (CFIA) acknowledged that some meat from the infected farm may have in fact ended up on consumers' dinner tables (Anonymous, 2005).

At the time, the CFIA reassured the public that the likelihood of multiple cases among cattle of the same age is rare, and that the risk to humans of contracting Creutzfeldt–Jakob disease, the human variant of mad cow, is low. Unlike what British officials did in that country's mad cow crisis in the 1990s, when they tried to control consumer fears by concealing facts, the CFIA tackled Canada's mad cow scare by communicating the disease's real risks and by maintaining a science-based public dialogue.

However, the key to communicating intrinsic risks to consumers is not only to share scientific facts but also to manage systemic uncertainty. During the mad cow crisis, the CFIA showed its intolerance toward ambiguous situations, which it perceived as a threat, when it broadcasted to consumers information on the status of our food supply in the hope that information will keep a lid on ambiguity (Diekmeyer, 2008).

When people feel uncertain about the food they eat, trust is not a trivial issue. Regulatory officials can regain public trust only by offering protection and information that satisfies public uncertainty. Most observers agreed that government officials in Canada did not mislead the public during the BSE ordeal, even if uncontrollable variables hindered their capacity to predict the outcome of certain strategies (Nikiforuk, 2005).

So how real is the risk of contracting Creutzfeldt–Jakob disease for consumers? Even though Canada banned the practice of rendering ruminants for cattle feed in 1997, ruminant feed was still readily available on the market, and violations of the ban have been reported (Brooymans, 2005). Regulators found that enforcing the ban was challenging.

Another problem at that time was the CFIA's own assumptions about the disease. Some of the agency's leading veterinarians declared that animals younger than 30 months could not develop BSE. Japan, which has made BSE testing compulsory for all slaughtered animals, discovered

two cases in 21- and 23-month-old animals (Kilman, 2005). Monitoring standards have since changed, which provide evidence that food systems do and are able to cope with changes in threats over time.

Within our food system, the CFIA walks a fine line between educating the public and trying not to alarm it, with the public's trust in the balance. Surveys over the years report that the vast majority of Canadian consumers unreservedly believe that our agricultural supply system is not endangering human health, and that they trust the safety of our food chain (Couture, 2009). But trust is fragile and can be obliterated in an instant. In other parts of the world, consumers were not so kind to food regulators and industries facing a BSE-driven predicament. By neglecting to nurture consumer confidence, industrialized nations such as Japan and Britain have paid a hefty price to regain the public trust their industries needed to regain profitability.

The Maple Leaf recall caused by a listeria outbreak in 2008 was another significant shock to our food system. Unlike the mad cow crisis in 2003, the Maple Leaf recall led to fatalities, 22 in total (Smith, 2010). Since the recall, the industry has changed. Certainly, Maple Leaf has changed: it revisited its protocols, and most industry elements were already following food safety practices that exceeded governmental regulations (Mason, 2009).

Some reports suggest that public authorities did not properly inform consumers about risks (Galloway, 2009). Consumers heard a confusion of voices and perspectives, which reduces the efficacy of every press conference, website, and article, as well as public investigations more generally. Shared accountability across supply chains should be at the forefront of any new food safety policies.

Occurrences such as the listeria outbreak at Maple Leaf made Canada, to an extent, food insecure. The recall had profound implications for Canadian consumers. As the Maple Leaf recall reveals, it is necessary that modern consumers understand that these episodes and their tragic outcomes can be minimized only by sound policies that address the complex, interlinked nature of our food economies.

Both events called for a systemic approach to food safety issues. Although they are very different, the Canadian mad cow crisis and the Maple Leaf recall are considered two pivotal incidents that changed how our food system operates. Since then, food safety became a common concern for most players within the food industry. These events, although they had negative consequences to consumers and organizations, depart from our society's previous expectations about how food systems should function. Complex, transnational issues like food safety, or other public health issues such as obesity, are major challenges that frustrate analysis and management by reductive methods.

Food Safety Systems

The foundations of food safety systems are similar to those of food systems generally. Safety—in the form of regulations, practices, and expectations—is conveyed from one element to another within the system. Exchanges allow information and resources to be shared. Supply chains must work in synchronization; participants are required to work simultaneously to provide safe foods to consumers. But relationships are bidirectional in nature. Systems calibrate through sharing responsibilities and become more accountable to one another. Consumers, too, are asked to share information with the system since they are intimately involved and part of it. The food chain across producer, processor, retailer, and consumer is highly interconnected and dynamic.

The chain of trust from suppliers to producers, to distributors, to wholesalers, to retailers, to end consumers, is essential for a highly functioning food safety system. A lack of legitimate representatives within the chain, failures to convince important stakeholders to participate, distances between participants, and the length and breadth of the supply chain are factors that limit joint action on crucial issues like food safety and traceability.

All elements play a key role, but consumers are our system's most central risk assessors (Labrecque et al., 2007). Consumers are the ones who risk, perhaps several times a day, buying food products from grocers, corner stores, street stands, eating at social events, and at other more or less familiar places. However, systems have demonstrated that they are often unable to provide information to the end consumer through proper traceability. Accordingly, it is noted that food choice is frequently swayed more by psychological analysis, such as perception of the brand, rather than physical properties of food products, such as the likelihood of food carrying a disease. Perception of food safety risk is skewed by psychological interpretations that influence attitudes and food buying patterns. Logic is habitually missing from consumer buying patterns. This fact can be explained as a result of the increasing incapacity of consumers to make their own assessments of the risk related to food threats and their dependence on public institutions to acquire strategic and suitable information (Markovina and Caputo, 2010).

More accurate assessments can be achieved through traceability. Traceability is an effective safety and quality monitoring system with the potential to enhance safety within food chains, as well as safeguarding the protection of consumers. Food traceability is the architecture behind all food safety systems. Shared responsibility throughout the food supply chain can in no way be evaded. Many have accepted that the BSE and Maple Leaf ordeals were part of a cycle in which conditions force us to enhance food safety systems already in place. Food traceability offers the

ability to trace and track the origins of any product throughout the food supply chain, at any level.

When implementing a more universal traceability program, one has to keep in mind that food retailing is one of the most competitive industries in our global economy. Food retailers must manage disproportionate operational overhead costs, low profit margins, and demand that is relatively elastic for many products. Demand price sensitivity is the key when a food traceability project may increase retail prices. Moreover, on the other side of the marketplace, farmers are often considered price takers and depend heavily on governmental farm subsidies in order to survive.

Despite its costs, food traceability is a vital aim that reinforces accountability. For government and health officials, it means having the ability to act quickly in a crisis situation and know where animals or products are in the supply chain (Rosolen, 2010). By no means it can bulletproof the industry from major food recalls in the future, but it may permit anticipation of the these types of crises and adoption of proactive attitudes throughout the food supply chain, adding value to Canadian commodities in the process. It will also ensure more rapid containment, potentially in real time, of food catastrophes that could harm consumers.

The tools and techniques of food safety are related to the discipline of public health emergency preparedness: protecting and securing the population's health require information about food safety systems and consumers themselves. Like public health preparedness, food safety is heavily reliant on technology. The use of technology can leverage a food traceability system that may increase and improve the types of information elements that the system can share.

To consider an example, the world is calling out for nanotechnology, particularly in agriculture, where the technology could play a significant role. Nanotechnology offers the opportunity to manipulate matter at the smallest scale possible to date and allows engineering of functional food products at a molecular level.

Nanotechnology may lead to advances in agricultural research in the decades ahead. Applications of nanotechnology in agriculture and food systems include improvements to reproductive technology, conversion of agricultural and food wastes to energy and other useful by-products using enzymatic nano-bio-processing, disease prevention, and enhanced health of plants and animals. Researchers in Canada have developed nanofertilizers that release nutrients as plants need them (Moore, 2010).

Some predict that by 2020 the global impact of products in which nanotechnology plays a crucial role will be roughly $1 trillion (Canadian) per year with significant benefits to the food industry in food processing, ingredients, nutraceuticals, and delivery systems. Packaging will also benefit from nanotechnology, allowing for more efficient food safety

monitoring (Dingman, 2008). Nonetheless, some have raised ethical concerns about nanotechnology and call for the contextualization of ethical discourse in its ontological, epistemic, and socioeconomic and political reflections (Ferrari, 2010). Open debate on nanotechnology is a prevalent topic among governments, research agencies, industry, and nongovernment organizations. With consumers, though, public perceptions about nanotechnology vary or are unclear.

Another noteworthy technology increasingly influencing food safety systems is radio frequency identification, also known as RFID. This technology has proven to be effective in traceability standards. The use of barcodes to identify products and lots has been the preferred technology since the late 1970s. Barcodes, however, are a read-only technology. RFID transceivers let data to be both read and written to a tag, which follows a product throughout the supply chain, providing stakeholders with better control and accuracy. Such a technology can increase the level of accountability for what is coming in and out of a facility. For the food industry, benefits from using RFID technology are higher reliability and higher rates of rejected products at the source.

More technologies in coming years will have a significant impact on how food systems assess, control, and contain food safety-related risks. It is difficult to pinpoint how far technology is capable of going and how willing consumers are to partake in sharing information within food systems.

The biggest challenge with large food recalls is finding the origin of the affected product, a task that rarely finishes as quickly as the companies and the public want. A food recall is often prompted by consumers registering at health clinics and hospitals after becoming ill from eating a contaminated product. The entire system must respond quickly upon recognizing these unofficial signals. Once recalled, hundreds, thousands, and sometimes millions of kilos of products are removed from the food chain, although the vast majority of it may not be unsafe. Proper technologies could trace and track products before and after process, throughout distribution, back to the processor, and even back to the farm from which a product came (Mehrjerdi, 2010). Accurate recalling is then more feasible. Existing technologies that allow this to occur are cost prohibitive for most companies and are ultimately thrown away by the end consumer. Research continues to supply affordable methods to the industry.

Supply Connecting with Demand

Food safety systems are influenced not only by supply-driven factors but also by demand, which is more fragmented than ever before. Elements of food systems are challenged by changing demographics, lifestyles, tastes,

and attitudes. Most demand-focused trends are shaped by the rural–urban divide. The roots of the rural–urban divide lie in the historical strategies of centrally planned systems that favored industrial development and agricultural surplus largely for urban capital growth and urban-based subsidies. Residents of large cities represent well over 85% of most Western countries' populations. This trend has created a significant disconnection between agriculture and consumers. Many consumers remain unaware of how and where food is made and often take it for granted. Affordable food prices have further widened the rural–urban divide because consumers can buy more food while thinking about it less.

However, consumers are becoming increasingly conscious about the origins and health safety of the food they consume. This shift is not to be taken lightly. Local foods have enjoyed a resurgence in the past two decades in Canada, the United States, and elsewhere. Consumers are attracted to these markets by an array of environmental, social, and economic factors, often related to the alleged benefits of local food channels. Many consumers seek authenticity in reaction to the increasing intensity of marketing channels (Smithers and Joseph, 2010). The search for authenticity is a radical rejection of conventional, industrialized production methods and will significantly impact how food safety systems evolve. That being said, many consumers still adhere to industrialized systems and do not question their integrity.

The ideal food safety system aims at mitigating risks in real time. That of course, as stated earlier, would be an ideal. But given how public regulators are challenged by budgetary constraints, it is only for the longer term that one country should think of real-time food safety surveillance as being possible. Food safety is and will remain a challenge for all industrialized countries, but what will test food safety systems is the notion of food authenticity and fraud.

Food fraud is not a new phenomenon; historically, it dates as far back as the Greek and Roman Empire. However, in recent years, better access to advancing technology has allowed us to quickly recognize food distribution failures. As a result, contemporary food fraud has frequently found itself in the media spotlight. Currently, the authenticity of food in general and the veracity of food labels in particular are major concerns for many, including consumers, regulators, and the food industry at all levels of the food continuum. In light of the European horsemeat scandal, we have come to realize that failures such as mislabeling can occur at global scales. If you think Canada is immune to fraudulent food labels, think again. Chances are you have already unknowingly purchased a food product with an inaccurate food label.

Regulators and the food industry are beginning to realize that the problem is far more widespread than first supposed. For example, a

recent study in the United States revealed a high substitution rate of 57% in meat labeling.

Consequently, there has been considerable dissonance between the contents of the product and the information found on its label. Similar results were found in a study involving chicken sausages in Italy. Not a month goes by now without a published study acknowledging how deeply problematic the situation is. This of course raises significant food safety and consumer protection issues. Allergens alone can pose significant risks to vulnerable consumers with medical conditions.

There are many reasons for the boom in fraudulent labels. The remarkable growth of food counterfeiting can be partially attributed to the increase in global trade, emerging new markets, and the steady increase in world food prices. Processors, agents, brokers, and distributors alike are often tempted to substitute ingredients or products to set an appropriate price point for a targeted market. In addition, resource scarcity, the potential for greater profits, and inadequate legislation have all encouraged, even made counterfeit labeling inevitable, the most common result of which is food fraud.

Over the years, some categories of food have been affected more than others. The most documented cases in the food industry have been with fish and seafood products, some of which have been reported in Canada. For example, DNA analysis of hake products commercialized in Southern Europe have demonstrated that more than 35% of fish packages were mislabeled on the basis of species substitution. However, in recent years, other categories have been targets: wines and olive oil, among others. There have been alleged cases of nonorganics being sold as organically grown commodities. The list, unfortunately, goes on.

The best solution for this problem is improved traceability. In the past, food traceability—the capacity to track food ingredients across supply chains—was promoted to improve food safety; it appears that increasing food fraud makes a case for the capacity for higher traceability. The enhancement of tracing systems alone is insufficient, however. Opportunistic behavior within our food system should also be monitored by food regulators. Unfortunately, the work of surveying the entire system regularly would be an overwhelming task. The Canadian food retail industry is a $120 billion business. It would be unrealistic and even undesirable to expect regulators to effectively monitor it. In addition, added public monitoring would likely result in increased bureaucracy and, certainly, higher food prices.

The food industry is just as concerned about food fraud as consumers; perhaps more so. Reported cases of inaccurate labeling can be devastating to both brand equity and the reputation of companies. The main driver for a reduction on food fraud cases is accountability within the

industry, and consumers have every right to expect it. More questions are being asked when goods are sold from business to business before it reaches consumers.

For the industry, however, the clock is ticking. Technological advances are making traceability more accessible, and soon consumers themselves will be able to self-authenticate the origins of food products and the validity of ingredients. Many devices and apps to carry out this function are in development worldwide. It will be interesting to track the response of industry and regulators once consumers have access to these tools. Millions of citizen regulators may not be feasible today, but it is a very possible reality for the very near future.

The lesson is, before consumers actually become part of food traceability systems in real time, industry should ensure food fraud becomes a problem of the past, and as soon as possible. For that, food safety systems ought to think about the ways to include consumers in the process of risk mitigation, by running a much more open system, embracing a market-based approach. This is likely the only opportunity that both industry and governments have to enhance systems regularly. That would be a long-term goal. As food safety systems mature thought, it is important to recognize some important elements, which make regulators and the industry equally efficient. Metrics are presented in the next section.

Comparing Food Safety Systems

Food safety systems from around the world evolve at different paces. They vary from country to country, as do methods of risk assessment, standards, and policies.

The *Food Safety Performance World Ranking Initiative* was designed to facilitate identification of the relative strengths and weaknesses in Canada's food safety performance. The goal of this approach was to assist academics, practitioners, and policymakers in assessing food safety systems and processes in Canada. It allows for better risk intelligence by federal regulators around the world. Risk intelligence is a matter of adopting better risk assessment practices to monitor risks proactively.

This book is the evolutionary tale of international benchmarking in food safety performance. We have conducted three different surveys over the last few years in 2008, 2010, and 2014. We first compare results between the first two surveys in 2008 and 2010 (Chapters 2–6). After chairing a summit on regulatory food safety performance metrics in 2011 in

Helsinki, Finland, how we measure performances have changed. Another survey was conducted in 2014, and results are presented in Chapter 7 of this book.

Metrics were different for the first two surveys. They were established based on comments and recommendations made by a group of academics back in 2006 and 2007 during meetings held in Canada and Italy. For these surveys, in addition to measuring Canada's food safety performance, the report also investigated its underlying causes and highlights policies that could improve food safety in the future. This report compared Canada's performance with 16 peer countries across four major categories:

1) Consumer Affairs
2) Biosecurity
3) Governance and Recalls
4) Traceability and Management

The Consumer Affairs category measured policies and outcomes that assess how well countries connect with their consumers. Surveillance efforts, hygiene practices, and information accessibility are the main indicators.

The Biosecurity category concerned a country's capacity to contain all relevant risks related to food safety. This included the rate of agricultural chemical use and a country's bioterrorism strategy—the latter being an increasingly important aspect of food safety in the twenty-first century.

The Governance and Recalls category looked at the effectiveness of domestic regulations and governance related to food safety. For example, the existence of risk management plans, the level of clarity of food recall programs, and the number of food recalls were some of the metrics considered.

Finally, Traceability and Management measured a country's ability to identify the location of food items and its knowledge of a food item's history. This evaluation included the depth of the traceability programs.

Performance in each category was measured using only the indicators that reflect the overarching goal of the study. Eleven indicators were considered and evaluated.

The purpose of this benchmarking framework was to identify and evaluate common elements among global food safety systems. Therefore, the primary objective of this study was not only to identify which country offers the safest food products to its citizens but also to recognize which countries employ comparatively best practices to contain risks related to the safety of food systems. This study analyzes the performance of 17 top

Organisation for Economic Co-operation and Development (OECD) countries, including Canada. These countries are

Australia	France	Norway
Austria	Germany	Sweden
Belgium	Ireland	Switzerland
Canada	Italy	United Kingdom
Denmark	Japan	United States
Finland	Netherlands	

This group was used for all categories, variables, and analyses. Countries were awarded a grade of "superior," "average," or "poor" for each category.

Methodology for the First Two Surveys

As for the 2008 inaugural edition, the State–Pressure–Response model was used as the study framework. This is a useful approach to understand policy reactions related to food safety. The report considered outcomes that measure results—not effort. Indicators were divided into three classes based on the adaptation of the State–Pressure–Response approach used by the OECD to benchmark the environment. This model has three components:

1) State (output)—Condition of food safety performance at the time of the report
2) Pressure (input)—Human primary or secondary activities that impact the condition of food safety systems either positively or negatively
3) Response (policy and actions)—Policies and actions that the country has initiated or will initiate to address food safety issues

This study focuses on indicators that can be influenced by public policy. The factors that were taken into consideration are those that can be modified or altered by individual, organizational, or public efforts. Indicators may directly or indirectly influence output. For example, a policy that makes livestock identification mandatory may augment the capacity of a country to track meat products across the food chain, thus reducing foodborne illness.

All indicators used to measure performance within a specific category met the following criteria:

1) The indicator provides valuable information concerning the performance or status of the particular food safety domain.

2) The indicator can be affected by policy.
3) The indicator secondary data are reliable and readily available.
4) The data are sufficiently consistent to allow benchmarking over time and permit a valuable international comparative analysis.
5) There is general agreement that a change in the indicator in one direction is better than a movement in the other.

The data for this study were based on secondary sources, such as the OECD, the World Health Organization (WHO), the United Nations (UN), national statistical agencies, and other food safety regulatory organizations based on the countries under study. The most recent data were used for each indicator.

The choice of comparator countries was significant. This study compared Canada with other OECD countries because of the greater likelihood that these countries have achieved high standards in food safety. Initially all 30 OECD countries were to be considered, but some were later disqualified. Luxembourg and Iceland were dropped because both have populations of less than 1 million. In addition, the study only considers countries with a gross domestic product above the OECD mean. Therefore, the 11 countries that fell below this mean were also omitted.

The inclusion of emerging economies like India and China was a possibility; however, they performed poorly on food safety indicators. Furthermore, countries where food security is still a significant concern were not appropriate candidates either.

For output indicators, a ranking system of superior, average, and poor was adopted—comparable to a report card. Input indicators were not ranked because it is difficult to determine whether a higher value reflects higher levels in food safety performance. Moreover, it is difficult to establish any relationships between output and input. Response indicators used the same overall ranking system as output indicators. However, instead of using superior, average, and poor, grades of "progressive," "moderate," or "regressive" were used.

For the actual world ranking, countries were ranked for each category and results were then aggregated to generate a world ranking. As with response indicators, each country was given a grade varying between superior, average, and poor, thus creating three tiers.

Limitations

Some limitations ought to be considered. Secondary data was not always available for some of the countries studied. More specifically, the research on non-English countries (such as Japan) was challenging. Some countries are also less transparent than others, which makes the data

collection process more intricate. A considerable amount of data were processed and analyzed with some level of subjectivity.

Secondly, this study includes research published between 2002 and 2010, which may skew results. Some agencies and countries publish reports every 2 years or so. In some cases, reports were only published once, which made it difficult to collect and consider current information on food safety.

Lastly, genetically engineered organisms (GEOs) are not considered in this study. When the project was originated, no conclusive evidence suggested that GEOs posed a health threat to consumers. Out-of-household consumption was also not considered because it would have made the variables more difficult to measure.

The evaluation of the 17 countries in this study occurs over four distinct categories comprising 12 criteria:

- Consumer Affairs:
  - Incidence of reported illness by foodborne pathogens
  - Rate of inspections and audits
  - Food safety education programs
  - Labeling and indications of allergens
  - Ease of access to public health information
- Biosecurity:
  - Rate of use of agricultural chemicals
  - Bioterrorism strategy
- Governance and Recalls:
  - Existence of risk management plans
  - Level of clarity and stability of food recall regulations
  - Number of protectionist measures against trading partners
  - Number of recalls
- Traceability and Management:
  - Depth of traceability system in food chain

Many scholars and practitioners from around the world reviewed these indicators, and data were collected and compiled for each category. Based on these data and the subsequent State–Pressure–Response model analysis, countries were ranked for each category, and results were then aggregated to generate a world ranking. Each country was given a grade of superior, average, or poor.

The world ranking and overall grade were derived in two ways. First, based on the grades over the four sections a country was placed in an overall grade category (superior, average, or poor). This informed a rough ranking, with superior-graded countries naturally ranking higher than poor-graded ones. Second, based on a country's average category rankings (between 1st and 17th), countries were then ordered within their

overall grade category. For example, Belgium, France, Germany, Ireland, and Italy all earned overall grades of poor; however, Belgium's world rank is higher than Italy's because it has a higher category ranking average.

As illustrated by Table 1.1, Australia, Canada, Denmark, Japan, the United Kingdom of Great Britain and Northern Ireland (UK), and the United States of America (USA) all earned grades of superior, owing to their comparatively progressive category grades. Austria, Finland, the Netherlands, Norway, Sweden, and Switzerland earned average grades, owing to their overall moderate performance. Finally, Belgium, France, Germany, Ireland, and Italy all earned grades of poor for comparatively regressive category grades.

Table 1.2 provides the category-specific grades and ranks for the 17 countries.

Table 1.1 World ranking.

			2008 Comparison	
Rank	**Country**	**Grade**	**Grade**	**Rank**
1	Denmark	Superior	Superior	3
2	Australia	Superior	Superior	4
3	United Kingdom	Superior	Superior	1
4	Canada	Superior	Superior	5
4	United States	Superior	Average	7
6	Japan	Superior	Superior	2
7	Finland	Average	Average	6
8	Netherlands	Average	Average	12
9	Austria	Average	Average	14
10	Norway	Average	Average	9
11	Sweden	Average	Average	13
12	Switzerland	Average	Average	8
13	Belgium	Poor	Poor	16
14	Germany	Poor	Average	10
15	Ireland	Poor	Poor	17
16	France	Poor	Poor	15
16	Italy	Poor	Average	11

Increased grade	No change	Decreased grade	No data

Table 1.2 Category-specific grades and ranks.

Country	Average rank	Consumer affairs		Biosecurity		Governance and recalls		Traceability and management	
		Rank	Grade	Rank	Grade	Rank	Grade	Rank	Grade
Australia	6.25	5	Average	11	Average	2	Superior	7	Superior
Austria	9	16	Poor	5	Average	9	Average	6	Superior
Belgium	9.25	11	Poor	15	Poor	7	Average	4	Superior
Canada	7.25	2	Superior	11	Average	1	Superior	15	Poor
Denmark	3.5	3	Superior	1	Superior	8	Average	2	Superior
Finland	7.75	14	Poor	1	Superior	15	Poor	1	Superior
France	11.25	9	Average	14	Poor	13	Poor	9	Superior
Germany	10.5	13	Poor	5	Average	12	Poor	12	Superior
Ireland	11	4	Average	13	Poor	14	Poor	13	Superior
Italy	11.25	17	Poor	15	Poor	10	Average	3	Superior
Japan	7.5	8	Average	8	Average	4	Superior	10	Superior
Netherlands	8.75	6	Average	17	Poor	5	Average	7	Superior
Norway	9.25	10	Poor	3	Superior	10	Average	14	Average
Sweden	10.25	11	Poor	4	Superior	15	Poor	11	Superior
Switzerland	12	14	Poor	7	Average	15	Poor	*	N/A
United Kingdom	6.75	7	Average	9	Average	6	Average	5	Superior
United States	7.25	1	Superior	9	Average	3	Superior	16	Poor

Increased grade	No change	Decreased grade	No data

*Insufficient data.

The average rank column provides a category average rank for each country, which was used—inside of the overall grade category—to provide a number-based overall world ranking.

Comparison with 2008

There were few overall grade changes in 2010 compared with 2008, as only Germany, Italy, and the United States moved up or down a grade level. Moreover, each country earned a world ranking that was close to its 2008 result. Austria and Italy had the largest shifts (each moved five ranks), followed by Germany, Japan, the Netherlands, and Switzerland (each moved four ranks). Generally, the countries that moved the most did so in a downward direction: the largest shifts were negative (Italy, Germany, Japan, and Switzerland). This mirrors the overall grade shift, as the United States was the only country to increase its grade while Germany and Italy each fell one level.

In the 2010 study, each country received a similar grade and generally ranked close to its 2008 study result. This reflects two important aspects of this study. First, as a comparative study, a country decreasing in grade or rank does not necessarily mean that the country is providing poorer food safety systems or standards. Instead, this might simply mean that its performance is *comparatively* worse than its peers in 2010 compared with 2008. Second, some of the category variables (e.g., the measurement of the number of protectionist measures against trading partners) were measured using the same category standards as 2008. In these cases, more countries earned top-notch scores in 2010 than in 2008, which reflect an *absolute* improvement. In other words, the 2010 grades and rankings, because they are similar to the 2008 grades and rankings, reflect the speed in which some countries are improving their food safety systems—surpassing the changes in other slower countries.

Because this was a comparative study, the United States was able to increase its overall grade without increasing any of its criteria-specific grades. The United States simply scored comparatively better across all four categories in 2010, compared with 2008. By comparison, Germany and Italy both received lower grades because of their decline, compared with their peers, in the Biosecurity category.

Highlights

Generally, the non-European countries (Australia, Canada, Japan, and the United States) tend to perform fair equally. In part, this may be a result of a more-integrated agricultural and food safety system on the European continent. Moreover, with the exception of Japan, each of these countries have fairly large populations, land masses, and regional variations. It was not surprising that Japan also scored within this group as its

unique food requirements ensure that it creates and adopts worldwide best practices.

Canada continued to perform very well compared with its international peers. Notably, Canada and the United States were tied in category grades, overall grade, and world ranking position. Like its continental neighbor and largest trading partner, Canada earned excellent grades and category rankings in Consumer Affairs and Governance and Recalls, performed decently in Biosecurity and fell short compared with the international average in Traceability and Management.

When Canada performed well (like in Consumer Affairs and Governance and Recalls), it ranked very well (earning second and first places, respectively). However, Canada's performance in areas where it is not setting international best practices was spotty, earning the country ranks of 11th and 15th in its average-graded Biosecurity and poor-graded Governance and Recalls, respectively.

As a result of increasing European integration, European Union (EU) member countries tend to perform similarly in many of the metrics. In part, this is a result of identical, EU-required national policies for several of the food safety criteria measured in this study.

The largest difference between EU-member countries emerges in areas where EU requirements are the weakest or individual national governments are required to demonstrate individual policy leadership. Perhaps ironically, the largest EU countries tend to perform the weakest compared with their smaller-state peers. This size distinction is most notable in the category grades, when individual State–Pressure–Response considerations are applied.

When applicable, Norway and Switzerland tend to perform best when adopting or participating in the EU or pan-European systems or standards. This specific pressure can be partly attributed to their participation in the common market.

Japan represents a unique food safety model, given its distinct needs. While it continues to perform well overall, Japan falls four world ranks to sixth in 2010. Special care was taken to ensure that the Japanese grades reflected its policies as they relate to the country's unique needs and pressures.

The categories with the largest grade improvements were Governance and Recalls and Traceability and Management. Biosecurity (owing in part to the new bioterrorism metric) was a generally poor category for all countries. It is particularly notable as the only category in which no country improved its grade compared with 2008. More data were available for the 2010 report, which helped to fill in certain gaps from 2008.

Results from the latest survey are intriguing. Some trends are emerging which may very well impact how food safety systems function and interact among themselves in years to come. In the next chapter, an in-depth analysis on how Canada's food safety system is performing is presented.