Comprehensive REVIEWS in Food Science and Food Safety

Comparison of Global Food Traceability Regulations and Requirements

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Abstract: The food traceability regulations of 21 Organization for Economic Co-Operation and Development (OECD) countries were examined with attention to whether these regulations are comprehensive for all food commodities and processed foods. The countries were evaluated based on responses to a series of questions that were developed to allow assessment of their traceability programs. The questions sought background information on whether: mandatory traceability regulation(s) exists at the national level within a given country; regulations include imported products, and the nature of required documentation for imports; an electronic database(s) for traceability exists and, if present, its accessibility; and labeling regulations allow consumer access and understanding of traceability. The examination ranked the countries that have specific traceability regulations for all commodities, both domestic and imports, as "Progressive," while countries with less broad or stringent regulations were ranked as "Moderate," and countries that were still in the developmental stage of mandatory or industry-led traceability requirements were ranked as "Regressive." Aggregate scores were developed from all of the rankings, determined on the basis of the questions, for each of the 21 countries, to provide an overall world ranking score. The aggregate scores were "Superior," "Average," or "Poor."

Keywords: traceability, food regulations, OECD, country rankings

Introduction

Increased activity of global trading of food items leads to various benefits and complications across different countries (Chang and others 2013). One of the complications is tracing affected products internationally and domestically when there is an incidence of foodborne illness or animal or plant disease. The complexity of traceability involved in following food throughout a supply chain makes the process of product tracking slow and inefficient in times of crisis (Barling and others 2009). Many developed countries have implemented new legal requirements for traceability, and exporting countries are under pressure to comply with the regulations set up by importing countries Germain 2003. Under these circumstances, it has become important to review the traceability regulations of each major nation and provide a comparative assessment to aid in discussions concerning global food traceability.

During the examination, observations were made about select industry-led requirements. In many countries these protocols and standards are precursors to or part of strategies to mitigate the need for government regulatory intervention. The inclusion of industry requirements and standards was not exhaustive and intended to illustrate the embryonic and multifaceted nature of food traceability in the subject countries.

With these basic premises established, the objective of this report is to summarize the existing global food traceability regulations in 21 major OECD countries, with observations of their strengths and weaknesses. Additionally, countries were ranked based on the nature and scope of their mandatory traceability regulations and the comprehensiveness of the regulations as assessed by the questions used in the methodology.

With mandatory regulations for traceability of food and feed being adopted in many European countries, member countries of the European Union (EU) as well as pan-European countries such as Norway and Sweden received an overall world ranking of Superior. Australia, Canada, Japan, Brazil, New Zealand, and the United States received an overall world ranking score of Average. China received an overall world ranking of Poor. Insufficient data were available for ranking the Russian Federation.

This examination led the authors to note the importance of harmonization of traceability requirements and regulations to minimize the potential for misunderstanding and delays due to difficulties in understanding each country's practices, to strengthen interoperability in order to overcome unintended trade restrictions, and to improve traceability of food products globally.

Considerations of some limitations are warranted in reading this report. With limited resources, accessible (public or acquired) data were not always available for some of the countries studied. More specifically, the research on non-English–speaking countries (such as China, Japan, and Russia, for example) was challenging. A few countries are also less transparent in dealing with requests for

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doi: 10.1111/1541-4337.12101

information than others, which makes the data-collection process more intricate. Some received data needed to be processed and analyzed with a level of subjectivity. In cases where there was a weak response or lack of transparency, the country ranking tended to be downgraded in order to err on the side of caution.

Scope of Research and Methodology

Countries included in this study were Austria, Australia, Belgium, Brazil, Canada, China, Denmark, Finland, France, Germany, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Russian Federation, Sweden, Switzerland, the United Kingdom, and the United States. These countries are considered top OECD countries in regards to food production and consumption, and they represent major exporting and importing countries of the world.

Most of the countries' traceability systems were studied previously at the national level by Charlebois and MacKay (2010). The research reported here provides further insight into traceability regulations at the international level. Although China was considered an emerging economy in the earlier research by Charlebois and MacKay, and has had certain issues with food safety in the past several years, the country was included in this study because it has become a major trading partner for countries such as the United States and the EU; and China was the largest market ($26 billion) for U.S. agricultural exports in 2012 (United States Department of Agriculture fact sheet 2013). China has also taken substantive steps to improve its food traceability and safety requirements in recent years (Limei and others 2012).

Products considered in investigating the traceability regulations of countries were agricultural food products, including meat, dairy, fresh produce, and seafood; processed and packaged foods; as well as live food animals intended for human consumption. Food products with special status, such as organic food and biotechnology-derived products, were not specifically addressed in this study. This study compares traceability regulations on generally available food products in the subject nations.

The existing traceability systems of each country were reviewed by researching publicly available documents (e.g., government regulations and industry guidance documents) and previously published research papers on the topic of food traceability requirements. An assessment matrix was developed to compare and rank each country's traceability-related status. Consideration was given to not only existing traceability policies but near-term or proposed regulations as well.

The research began with critical reading and literature review of prior studies of national rankings of food safety regulations and journals relating to traceability studies in different countries. From these reviews, an assessment matrix, based on 10 questions, was created in order to compare the traceability requirements and regulations of each country. Next, information about food traceability in each country was acquired through subject matter experts and internet search of published information to identify the required data for each of the assessment questions. Within this structured framework, the countries were then comparatively ranked.

Assessment questions

The 10 questions designed and used to assess countries' food traceability requirements and regulations are shown in Table 1. The questions are further explained in the subsequent subsection entitled Rationale for Metrics.

Country rankings were produced based on the findings that related to each question of the assessment matrix. Through the matrix, the status of each country's traceability regulations was rated as "Progressive," "Moderate," or "Regressive." This ranking system is consistent with previous research in this area (Charlebois and Hielm 2014). A Progressive ranking was used for a country with comprehensive and mandatory national traceability regulations for domestic as well as imported products, and applicable to a wide range of food products (e.g., beef, seafood, and produce). A Moderate ranking was used for countries with at least one national mandatory scheme for traceability that is not as developed or comprehensive as the regulations in Progressive countries. A Regressive ranking was reserved for countries that are still lacking traceability regulations and/or are at the beginning stages of food traceability implementation.

The "State-Pressure-Response" model, described below, was used as the assessment approach. This is a useful instrument for understanding policy reactions related to food safety risks, given that systemic risks change constantly. This research considered only measurable outcomes and did not consider efforts that could not be measured. Indicators were divided into 3 classes, based on the adaptation of the State-Pressure-Response model used by the OECD to benchmark. This model has 3 components:

1. *State* (output) refers to the condition of food traceability practices at the time of the report.
2. *Pressure* (input) refers to primary or secondary human activities that impact the condition of food traceability practices either positively or negatively.
3. *Response* (policy and actions) refers to the policies and actions that the country has initiated or will initiate to address food traceability issues.

This study focused 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 the 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. Secondary data about the indicator 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 OECD research, and information available from the World Health Organization (WHO), the United Nations (UN), the Institute of Food Technologists (IFT), and national statistical agencies (e.g., U.S. Dept. of Health and Human Services, and Statistics Canada) and food safety regulatory agencies based in the countries under study. The most recent data were used for each indicator, but in some cases, recent references were challenging to find.

Table 1–Traceability assessment questions

1.	Are there specific regulations/policies on national level for domestic products? When did these policies come into effect?
2.	Are there specific regulations/policies for imported products? What documents required for import products to address traceability?
3.	What is the clarity of the system of authority responsible for traceability regulations?
4.	If no specific regulations, are there voluntary practices by industry?
5.	What products or commodities are being regulated for traceability?
6.	What kinds of identifiers are being used for tracking/registering of imports (e.g., ear tags, barcodes, RFID)?
7.	Are GFSI benchmark standards recognized?
8.	Are GS1 services (i.e., traceability tools and coding standards) available?
9.	Is there an electronic database system used for monitoring imports/export and their traceability? Are these systems accessible by importing countries?
10.	What information on packaging labels is available for the consumer to understand traceability?

This study compared 21 OECD countries because of the greater likelihood that these countries have achieved high standards in food traceability. Initially all 30 OECD countries were considered, but some were later disqualified. For example, Luxembourg and Iceland were dropped because both have populations of less than one million. In addition, the study only considered countries with a gross domestic product above the OECD mean (nominally US $36,837 per capita); therefore, countries that fell below this mean were considered for omission.

The inclusion of emerging economies such as India was a possibility; however, access to data was challenging within the timeframe of the research effort. Furthermore, countries in which household food security is still a significant concern were not appropriate candidates given that food insecurity often supersedes food safety and food integrity initiatives. These are gaps in this current assessment and create opportunity for future investigation.

For output indicators, a ranking system of Progressive, Moderate, and Regressive was adopted, comparable to a report card. Input indicators were not ranked because of the difficulty in determining whether a higher value reflects higher levels in food traceability performance. Moreover, it is difficult to establish direct relationships between output and input. Response indicators used the same overall ranking system as output indicators.

For the actual comparative ranking, countries were ranked for each category (question) and the results were then aggregated to generate a comparative world ranking. As with response indicators, each country was given a score of either superior, average, or poor, thereby creating 3 tiers.

Rationale for Metrics

1. Are there specific regulations/policies on the national level for domestic products? When did these policies come into effect?

This topic examines whether products available domestically are subject to mandatory traceability regulations by the government, and when these regulations were enacted. Before examining the gaps and strengths of a traceability system for the global market, it is important to realize whether each country has its own traceability system for domestically produced products and the depth or extent of its regulations.

2. Are there specific regulations/policies for imported products? What documents are required for import products to address traceability?

This topic is based on the hypothesis that food products being imported may or may not be subjected to the traceability regulations of that country. If there are any specific requirements for imported food, how they differ from regulations for domestic products is a consideration.

3. What is the clarity of the system of authority responsible for traceability regulations?

Responsibility for monitoring and implementing national traceability systems may exist at different levels of government and within industry-led associations. For example, the Canadian Food Inspection Agency (CFIA) enforces traceability through the Health of Animals Act, and it has accountability for animal identification programs for beef, dairy, bison, and sheep, while administration of traceability investigation programs is shared by provinces within Canada (Charlebois and Mackay 2010). This question evaluates that regulating bodies are responsible for traceability, and how clearly defined their roles are.

4. If there are no specific governmental regulations, are there voluntary industry practices?

The literature reviews showed that only some countries have mandatory traceability regulations; and where they exist, regulations are restricted to specific commodities. For example, Japan and Norway have established traceability systems for animals and animal products, but only for a few foods and other commodities. In the United States, traceability practices are mainly industry-led, for example, the Product Traceability Initiative (PTI; Charlebois and Mackay 2010). In countries where there is no mandatory regulation in place, the research investigated whether there is any traceability practice or initiative being undertaken by the food industry.

5. What products or commodities are being regulated for traceability?

Specific food commodities were examined for specific traceability regulations. Similar to Question 4, this question assesses what specific foods are affected by national traceability rules and regulations in the countries.

6. What kinds of identifiers are being used for tracking/registering of imports (such as ear tags, barcodes, RFID)?

In the instances of an existing national traceability regulation for domestic and/or imported products, the research examined what kinds of identifiers are being used for tracking the products. Common tracing identifiers include alphanumeric notes, barcodes, radio frequency identification (RFID), inkjet, and laser etching.

7. Are Global Food Safety Initiative (GFSI) benchmark standards recognized?

The GFSI benchmarking standards are becoming increasingly accepted as a form of third-party certification and verification of food safety management systems. GFSI is an industry-led program and as such is not in the regulatory domain; however, its growing

transnational use does make it an important factor to consider in food traceability requirements. Many of the GFSI benchmarking programs include a section on traceability and recall to ensure that food producers are able to trace food products forward or backward in case of emergency. Therefore, GFSI requirements could be used as a standardized validating tool across different countries to ensure effective traceability practices are present in a food producer's management program.

8. Are GS1 services (such as traceability tools and coding standards) available?

GS1 is an international not-for-profit association dedicated to the design and implementation of global electronic commerce standards and solutions to improve the efficiency and visibility of supply and demand chains globally. The GS1 system of standards is the most widely used supply chain standards system in the world.

GS1 electronic commerce tools and identifiers—such as global location numbers, GS1 corporate prefixes, global trade identification numbers, and barcodes—and associated services have become widely accepted in more than 100 countries and across many industries. The use of standard identifiers facilitates tracking and tracing of products more efficiently across different international markets. While not strictly a regulatory item, GS1 standards are nevertheless often closely associated with uniform requirements and implementation of traceability schemes and systems.

9. Is there an electronic database system used for monitoring imports/export and their traceability? Are these systems accessible by importing countries?

Many countries are utilizing electronic databases for managing information such as animal and premise identification and to facilitate the storing and transferring of information when animals or products are moved from one location to another. An example is the Canadian Livestock Tracking System (CLTS) that identifies live cattle and bison with RFID tags. The use of such technology is intended to increase reading and electronic data gathering efficiency and accuracy when there is a need to track diseased animals.

10. What information on packaging labels is available for the consumer to understand traceability?

Packaging labels are a convenient way for consumers to recognize the identification and origin of food products. Product identification and printed dates on labels allow consumers, retail stores, and regulatory agencies to quickly identify suspected lots or batches of recalled products when such notices are issued. This question is designed to assess whether there are labeling regulations in place in the country as a part of a national traceability management and where regulatory responsibility lies. Rankings were based on the comprehensiveness of labeling regulations.

Literature Review

Benchmarking in food safety

The identification of best practices is generally associated with benchmarking and initiatives to enact improvement and strategic organizational change (Seegar 2006). Benchmarking is a systematic process for discovering what is the best performance being achieved and whether it is based upon internal or external comparisons within the same activities or completely different functionalities (Manning and others 2006). Benchmarking is also a process for obtaining a benchmark or a measure; in simple terms, a benchmark is the "what," and benchmarking is the "how." However, benchmarking is neither a quick, simple process or tool nor a one-time event (Stroud 2010).

Benchmarking for best practices generally takes one of 2 main forms: the functional or generic form and the competitive form. However, benchmarking efforts may also be internally driven, to set better standards or to set best practices. The functional or generic form of benchmarking encompasses activities involving external organizations that may not necessarily be in direct competition with the organization in question. In the competitive form, benchmarking activities take place on products, services, or processes of direct competitors (Manning and others 2006; Jack 2009). For example, in farming and some food companies, benchmarking for best practices is mainly in the generic form, with some examples of internal benchmarking; however, very few cases of competitive benchmarking have been identified (Jack 2009).

Many believe that effective benchmarking can deliver benefits such as inspiring change by providing data, evidence, and success stories; identifying areas that require change or transformation or innovation; as well as delivering concrete benefits in business and government performance through improved product or service quality and productivity (Jack 2009; Balazic and others 2014).

Some observers argue that food safety is at greater risk because of the expansion and globalization of food systems (Balazic and others 2014). Due to rapid transport of raw ingredients and products across the globe, hazards can spread quickly and, therefore, many more people can be affected than before. Also, the globalization of news (e.g., TV, Internet) has the ability to instantly spread the bad news and cause unfavorable economic consequences for producers (Hoorfar and others 2011). The globalization and growing complexity of food supply chains, variations in food safety regulations across countries, and lack of uniform requirements from one commodity to another are among some of the reasons why global food safety benchmarking is required. Therefore, benchmarking would provide a valuable tool in understanding the capabilities and performance of food safety and traceability regulations, as well as point to issues and gaps that may need to be addressed.

Also, global benchmarking activities may have the benefit of allowing transitional economies to recognize and adopt best practices and successful schemes, as well as upgrade food safety performance for their producers and exporters in order to secure the best market opportunities (Baines and others 2006). For example, after the case of melamine-contaminated milk in China, in 2008, the Chinese dairy sector used benchmarking that was already standard within the EU to rectify their main issues of compliance. This work enabled China to prepare a new legislative framework and upgrade its food safety standards to meet the requirements of Codex Alimentarius and the EU (Pei and others 2011).

Studies using benchmarking frameworks have helped to identify and evaluate common elements among global food safety systems. These studies not only provide the tools needed to identify the country that offers the safest food products to its citizens, but also helps recognize the countries that employ the best practices to contain risks related to the safety of larger food systems (Charlebois and MacKay 2010).

The food safety performances of different countries can also be compared using ranking models, which can provide further insights beyond those possible within the framework of a benchmarking study. By using ranking models, not only can the countries be compared to one another, but the results can also be made more easily understood by a public generally unfamiliar with the complex mechanics of the global food system. This communi-

cation issue has become increasingly important as transparency and accountability have become major concerns. Thus, by building upon benchmarking studies and providing a reliable ranking model, we may be closer to a unique methodology which may lead to legitimate and recognized food safety standards that can be implemented across the industrialized world (Balazic and others 2014).

Food traceability

The occurrence of bovine spongiform encephalopathy (BSE) in cattle around the world in the late 1990s and early part of this millennium led to mandatory livestock identification and traceability programs in many countries, which improved confidence in the global trading of live animal and related meat products (Charlebois and Camp 2007). The finding of BSE in Canadian cattle in 2003 led to border closure for exports and resulted in a CAD $5.3 billion loss for Canadian beef producers by the end of 2004 (Statistics Canada 2006). Mandatory traceability in other food sectors or commodities is still lacking across nations; thus, governments and the industry are developing requirements, programs, and voluntary practices.

Traceability is generally defined as the ease with which a product can be traced throughout the supply chain, from farm or point of production to the end user. The Codex Alimentarius Commission states in its document CAC/GL 60-2006: "The traceability/product tracing tool should be able to identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward), as appropriate to the objectives of the food inspection and certification system" (CAC 2006). Traceability can be used as a tool to achieve 3 main objectives: managing risks related to food safety and animal/plant health issues, guaranteeing product authenticity and providing credible information to customers, and improving quality and processes of products by identifying noncompliance (Germain 2003).

Traceability systems require some form of recording medium, such as paper or more advanced computer-based data storage programs. There are numerous electronic database programs developed for animal identification and movement, such as Europe's TRAde Control and Expert Systems (TRACES), which manages livestock identification and movement from birth to slaughter within European countries. However, a singular database storage and product tracing system has not yet been developed for tracing all foods and commodities in any of the nations studied. Therefore, the process of traceability during emergencies and recalls still relies on manually sorting and comparing lot identifiers, processing records, trade documentation, and internal company inventory and supply-chain records. This contributes to inefficiencies and delays, as cited by Barling and others (2009).

Traceability relies on information, which must be reliable, relevant, and readily and rapidly accessible. Inefficient record-keeping systems; human errors in data recording during batching/formulation and shipping, and inconsistent information from suppliers can all lead to complications in traceability and the ability to identify and retrieve implicated products (Newsome and others 2011). David Acheson, former Assistant Commissioner of the U.S. Food and Drug Administration (FDA) is quoted (Washington Post, January 23, 2011) as saying, "The need for better traceability became clear after a national outbreak of salmonella illness in Spring 2008 that sickened more than 1,300 people across the country. Initially, investigators at the FDA and the Centers for Disease Control and Prevention (CDC) identified tomatoes as the culprit, and warned the public against consuming them. But more than a month later, FDA investigators correctly identified the source of the outbreak as peppers from Mexico. The delay was partly because of the chaotic record-keeping of the growers, distributors, wholesalers and retailers."

In the meantime, the cost to tomato growers in Florida alone was estimated at about $100 million.

More advanced challenges to traceability occur when commodities are being traded internationally since countries use disparate traceability regulations and requirements. Commonality and predictability are important when it comes to a serious foodborne crisis; it becomes crucial that affected products be successfully traced and removed from the supply chain as quickly as possible. Consumers perceive traceability as a guarantee of safe and high-quality products as well as dependable information about a product's condition (Germain 2003).

Comparative analysis of food traceability

In 2010, a comparative study was conducted in 4 areas of food systems, including traceability, in 17 OECD countries (Charlebois and Shoyama 2010). The study evaluated the depth of the countries' traceability systems and scored them based on their comprehensiveness. EU countries studied were rated as Progressive, while Australia, Japan, and Norway were rated as Moderate. Canada and the United States were rated as Regressive, due to the lack of a comprehensive farm-to-fork traceability system at that time. The analysis was primarily based on determining whether traceability systems being managed in those countries were comprehensive and whether they represented farm-to-fork traceability for all commodities. The study provided a background for further research into traceability systems of domestic and imported products in these countries.

The U.S. Meat Export Federation (USMEF) released a study in 2010 entitled "Economic Assessment of Evolving Red Meat Export Market Access Requirements for Traceability of Livestock and Meat," which compared cattle traceability systems in several countries (Brester and others 2011). The study found that many countries established animal identification and traceability systems to improve market access, producer profitability, and supply chain coordination and to enhance producer management opportunities (USMEF 2011). According to the report, the United States was one of only 2 major beef exporters that did not already have mandatory red-meat traceability systems. Argentina, Brazil, Australia, Japan, New Zealand, Canada, and Uruguay all had animal identification programs in place for tracing livestock movement. Compared to these countries, the United States lacked similar standards for livestock identification and for traceability of processed foods. The report remarked that this potentially placed the country at a disadvantage for growth into future export markets.

While animal identification and traceability has been strong in many developed countries, traceability of other commodities such as seafood has been a challenge, especially in regards to less-developed countries (O'Hara 2012). In 2009, a study on "Understanding China's Fish Trade and Traceability Systems" (Clarke 2009) revealed disparate information, especially on certificate-of-origin declarations of seafood brought into China by the United Kingdom, Denmark, the United States, Iceland, Norway, and The Netherlands. The report highlighted the importance of import documentation and the finding of significant lack of information on routine audits of traceability practices in the seafood sector. The study showed that other than for livestock, there is a lack of traceability in other sectors and that it is important

to have uniform requirements on products being imported from different countries.

Research Analysis—Findings and Results

Country rankings were produced based on the findings that related to each question of the assessment matrix. The status of each country's traceability regulations was rated as "Progressive," "Moderate," or "Regressive," The following briefly explains each of the 10 questions of the assessment matrix.

1. Are there specific regulations/policies on the national level for domestic products? When did these policies come into effect?

Most of the nations examined have established traceability systems for specific foods and agricultural products at the domestic level. The EU countries of Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Sweden, and the United Kingdom all follow the mandatory regulation of EU Legislation 178/2002, which includes requirements for the traceability of food, feed, food-producing animals, and any other substance incorporated into food or feed. The regulation was initiated in 2002; since 2005 it has been mandatory for EU countries to adopt animal traceability through animal identification and movement tracking programs. Every Member State of the EU region must establish a cattle identification and registration marker for individual animals and plot this single animal within the larger system with individual ear tags and computerized databases, and they must have a means to demonstrate the history of an animal with individual registers kept on each location holding the animal (Europa 2011).

Regulation (EC) No. 178/2002 OF the European Parliament and of the Council of January 28, 2002, laid down the general principles and requirements of food law, establishing the European Food Safety Authority and procedures in matters of food safety. The regulation requires food business operators to: (1) be able to identify from whom and to whom a product has been supplied; (2) have systems and procedures in place that allow for this information to be made available to the Competent Authorities upon request. The requirement relies on the "one step back"–"one step forward" approach, which means to have data that confirm from which supplier a product is received and to which customer a product is sent.

As a part of a system of beef traceability from farm to fork, the EU established mandatory beef labeling regulation (EC) 1760/2000 in 2000. As of January 2002, beef labels must include precise information about where the animal was born and reared, as well as the place of fattening, slaughtering, and butchering (Europa 2011).

Article 18 does not specify what type of information should be kept by the food and feed business operators. However, to fulfill the objective of Article 18, the following information, at a minimum, should be kept.

- name, address of supplier, and identification of products supplied;
- name, address of customer, and identification of products delivered;
- date and, where necessary, time of transaction/delivery;
- volume, where appropriate, or quantity.

Article 18 does not specify a minimum period of time for keeping records; therefore, it is for the businesses to decide, bearing in mind that failure to produce adequate records would constitute an offence.

Article 18 does not require internal traceability (i.e., the matching of all inputs to outputs). Nor does it require that records be kept identifying how batches are split and combined within a business to create particular products or new batches.

EU legislation also has specific requirements on seafood traceability. Article 58 of EC 1224/2009 requires that "all lots of fisheries and aquaculture products shall be traceable at all stages of production, processing and distribution, from catching or harvesting to retail stage" (EC 2009). The regulation requires that all lots of such products must conform to labeling requirements with identification numbers including the name and address of the suppliers.

Other European countries, such as Norway and Switzerland, that are not EU members adopted rules that are similar to EU regulations on traceability requirements and have established their own system for tracing and tracking certain food products. In accordance with the Swiss Parliament's legislation in 1999, Switzerland has established an animal identification system called "Identitas" (Identitas 2014) to track and trace cattle.

Since 2005, Australia has focused strongly on livestock traceability through their National Livestock Identification System (NLIS) that has mandatory requirements for the tagging and identification of cattle, sheep, and goats. Through a national animal identification system and registration in the NLIS database, the program monitors the lifespan of individual animals, from birth to slaughter, and the movement of livestock.

Similarly, the New Zealand Food Safety Authority (NZFSA) and the Ministry for Primary Industries (MPI) mandated the identification and traceability of cattle (July 1, 2012) and deer (March 1, 2013) through its National Animal Identification and Tracing initiative (NAIT; NZMPI 2013).

Brazil has implemented a mandatory traceability and identification system for livestock through the Brazilian System of Identification and Certification of Origin for Bovine and Buffalo (SISBOV). The SISBOV system was originally intended for exporters into European market, but it became mandatory in Brazil for the identification and control of both domestic and imported cattle (Bowling and others 2008).

The Japanese Handbook for Introduction of Food Traceability Systems (Japan Ministry of Agriculture, Fishery and Foresty 2008) provides comprehensive guidance to food standards in accordance with Japanese Agricultural Standards (JAS) and traceability requirements. The Japanese Ministry of Agriculture, Fishery and Foresty (JMAFF 2008) assisted with the development and publishing of the Handbook and has mandates under its Beef Traceability program for domestic beef requiring that an assigned number is carried through from the birth of the animal, to the carcass at the abattoir, and the label on (or the invoice of) the final packaged product. The assigned identification number allows consumers to review online the history of the beef products that they purchase. In addition to these beef traceability regulations, Japan also implemented a rice traceability regulation July 1, 2011 (USDA/ERS 2014). The Rice Traceability Act states that domestic producers and importers of foreign rice and rice products must retain records on receipt and shipment, including information about the source of the product (Japan External Trade Organization 2011) The Handbook also provides guidelines for voluntary traceability of other commodities, such as fruits and vegetables.

China is in the development stage of traceability regulations, and is emerging with different food safety regulations to address

part of its national traceability requirements. As of June 1, 2009, Articles 36–41 of the Food Safety Law require food producers, processers, packers, and retailers to implement testing and record-keeping systems for all inputs and outputs and to archive the records for at least 2 years (Zhang and others 2012). Also, according to Decree No. 67 (2006), the Ministry of Agriculture of the People's Republic of China requires pig, cattle, and sheep to be identified with an ear tag system with a 2-dimensional (2D) barcode (Ben-hai and others 2010).

Despite its late start on food traceability, China has accelerated its requirements, both in terms of industry practice and regulatory development, in the past decade (AMR 2012), and is coming into alignment with international practices. In 2009, the "Food Safety Law of PRC" and its implementing regulation were promulgated, requiring food producers to establish a purchase-inspection record system and a food-delivery-inspection record system, and accurately record information relevant to purchase or sale. Due to its highly publicized contamination issues in the dairy sectors, in September 2010, China issued a decree to further strengthen dairy quality and safety, which expressly proposed to "improve the dairy traceability system" and "implement electronic information traceability system." In November 2010, a revision of permit conditions for infant formula milk powder production reinforced that dairy enterprises establish an "electronic information traceability system," and standardize their quality control information on key processes or critical control points that need to be recorded.

In Canada, livestock identification is a part of animal traceability that is being enforced. This system requires cattle, sheep, and bison, and will in the near future require pigs and goats to be registered and tagged with identification numbers from birth to slaughter (CFIA 2013a). Livestock traceability systems are based upon the 3 basic elements of animal identification, premises identification, and animal movement. The policy is regulated by the Health of Animals Regulations and enforced by the CFIA (2013b). Effective July 2014, hog farmers and other industry custodians will be obliged to keep records and report all movements of pigs, from birth or import to slaughter or export (CFIA media release, February 26, 2014; CFIA 2014b). The regulations detail how farmed pigs and farmed wild boars are to be identified. The regulations are to come into force on July 1, 2014, for all domestic pigs that are farmed for food production, including those that die on-farm and cannot enter the food chain. Effective July 1, 2015, the regulations will be extended to also include farmed wild boars (CFIA 2014b).

For other food commodities in Canada, there are no specific traceability regulations. However, traceability of processed food products is verified through proper packaging and labeling in accordance with the Consumer Packaging and Labelling Act and Regulations, and the specific Act and Regulations for a given food commodity, as well as by Food Safety Enhancement Programs (FSEP) for meat products. For example, traceability of meat and poultry products is monitored and verified through the FSEP section of its Recall System. Federally regulated processing plants are required to have established HACCP plans and Prerequisite Programs and be able to demonstrate product recall and traceability (CFIA 2013a, Figure 1.1.1) and product coding and labeling (CFIA 2013a, Figure 1.1.2).

In the United States, the Bioterrorism Act of 2002 (BT Act), and the recordkeeping requirements contained in the Act, represented a step forward in the implementation of a product tracing system for FDA-regulated food products. The BT Act required a trail documenting food distribution, to aid determination of the source of contamination in the event of a foodborne illness outbreak. Until that time, the United States lacked traceability requirements or regulations at the national level.

Those who "manufacture, process, pack, transport, distribute, receive, hold, or import food," and foreign food transporters in the United States are required to maintain records to identify the previous sources and subsequent recipients of a food. Exclusions include: farms, restaurants, food processed for personal consumption, and outer packaging not directly contacting a food. Direct-to-consumer distributors are not required to keep records of the people to whom they sell. Food transfers within a company are not subject to recordkeeping. Also excluded are food samples used for quality assurance, research, or analytical purposes that are not consumed.

In 2011, as a part of the Food Safety Modernization Act (FSMA), the U.S. Department of Agriculture (USDA) introduced Animal Disease Traceability requirements for livestock being transported across state boundaries. Finalized in late 2012, the regulation requires that livestock moved interstate be officially identified and accompanied by an interstate certificate of veterinary inspection or other documentation.

There was no information found for traceability regulations for the Russian Federation, although there are numerous regulations and sanitary standards for domestic and imported food and biotechnology products (USDA/FAS 2013a).

Table 2 shows the rankings of the countries, based on their existing mandatory traceability regulations. European countries that have adopted the EU's mandatory traceability are ranked as Progressive. Canada is ranked as Moderate, due to the presence of mandatory traceability for livestock through its animal identification system and the as-yet-unfinished development of a process for regulating other commodities. Similarly, Australia, New Zealand, Brazil, and Japan are ranked as Moderate due to having a mandatory system for specific, although not all, commodities. Lastly, the United States and China are ranked as Regressive because their specific traceability regulations are either limited or not yet fully implemented.

Table 2–Rankings of countries based on traceability regulations for domestic products.

Country	Ranking
Australia	Moderate
Austria	Progressive
Belgium	Progressive
Brazil	Moderate
Canada	Moderate
China	Regressive
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Moderate
The Netherlands	Progressive
New Zealand	Moderate
Norway	Progressive
Russian Federation	No data
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Moderate

2. Are there specific regulations/policies for imported products? What documents are required for import products to address traceability?

The traceability of imported products in the countries studied was assessed using the same metric as that employed for domestic products (Table 3). International trade is conducted in accordance with contractual agreements between countries; and the products being imported must meet the standards of identity, food safety regulations, and traceability established by the importing countries. Placing strict border controls on imported products and ensuring that relevant documentation is available when it is requested by authorities are part of the traceability chain in the event that a product needs to be tracked and traced.

EU legislation for the traceability of all food and feed products applies not only to domestic but also to imported products. Specifically, Articles 11 to 13 of EU Regulation 178/2002/EC state that the requirements for EU Member States and third-party importers of food or feed must be in compliance with relevant food laws. The EU's traceability requirement for livestock, beef, and veal products also applies to importing countries. Imported livestock must maintain the identification of individual cattle through ear tagging and registration. Animals being transported to different EU Member States must be identified individually with ear tags and "passports" and must be recorded in a computerized database that maintains data on movement. Imported beef products must follow EU labeling legislation 1760/2000, which calls for details of product origin, such as country of origin, fattening, and date of slaughter, to appear on-label or at the point of sale for unwrapped products (Europa 2011).

In Canada, the CFIA is responsible for overseeing that the importing and exporting of food products are regulated under pertinent-specific legislation, such as the Meat Inspection Act, Food and Drug Act, and their regulations. Country-specific import requirements can be very specific in regards to certain commodities, such as meat products, to prevent the potential occurrence of animal diseases (BSE, for example). The CFIA provides information on requirements for exporting to certain countries, specific declaration statements, and other documents needed to meet regulations. For example, the exportation of meat products to the United States requires product lot information as well as detailed information about the origin of raw meat, including slaughterhouse and slaughter date information (CFIA 2013c). For meat products being exported to EU countries from Canada, the meat cuts must be compliant with the EU labeling requirements of 1760/2000.

Most OECD countries require conventional export or import permits, animal or plant health certificates, and other generic trade agreement certificates such as those available through the North American Free Trade Agreement (NAFTA) and custom declaration forms. At a minimum, documentation must include product identity, importer information, lot code information, and quantity of product being traded. Additionally, importers are required to ensure that products meet the standard of identity, labeling, and sanitary practices as stated by imported countries. Such information helps with the tracing and tracking of products that are being traded internationally.

3. What is the clarity of the system of authority responsible for traceability regulations?

Traceability regulations and policies in OECD countries are established and monitored by government sectors dealing with food safety, agriculture and health departments, and the ministers of these portfolios. Table 4 shows the ranking of countries concerning the clarity of the authority that exists. For European countries, the heads of the relevant ministries are responsible for ensuring that traceability regulations are being followed. For example, the Swedish National Food Agency; the UK Food Standards Agency; the Italian Ministry of Agriculture; the Food Safety Authority of Ireland (FSAI); Meat and Livestock Australia; China's Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) and its Food and Drug Administration (CFDA); Japan's Ministry of Agriculture, Forestry and Fishery (MAFF); the Norwegian Food Safety Authority; Brazil's Ministry of Agriculture, Livestock and Food Supply (MAPA); Canada's CFIA; and the U.S. FDA, USDA, and USDA's Animal and Plant Health Inspection Service (APHIS) are responsible for traceability regulations in their respective countries.

In Canada, mandatory livestock identification and tagging of cattle, sheep, and bison are regulated by the Health of Animals Regulations. The Canadian Cattle Identification Agency (CCIA) is the national administrator authorized by the CFIA to issue and regulate approved RFID tags and monitor the reporting database—the Canadian Livestock Tracking System (CLTS). CFIA enforces and audits CCIA management of the system. Tagging of cattle

Table 3–Rankings of countries based on traceability regulations for imported products.

Country	Ranking
Australia	Moderate
Austria	Progressive
Belgium	Progressive
Brazil	Moderate
Canada	Moderate
China	Regressive
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Progressive
The Netherlands	Progressive
New Zealand	Moderate
Norway	Progressive
Russian Federation	No data
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Moderate

Table 4–Rankings of countries based on the clarity of the system of authority responsible for traceability regulations.

Country	Ranking
Australia	Progressive
Austria	Progressive
Belgium	Progressive
Brazil	Progressive
Canada	Moderate
China	Moderate
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Progressive
The Netherlands	Progressive
New Zealand	Progressive
Norway	Progressive
Russian Federation	No data
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Moderate

with approved identification is required for both domestic and imported livestock. In addition, provincial governments play a role in the traceability of products in their regions. For example, Canadian provincial regulatory agencies such as the Ontario Ministry of Food and Rural Affairs (OMFRA), Quebec's Agri-Traçabilité Québec (ATQ), and Alberta's Agriculture and Rural Development support the implementation of traceability systems for dairy cattle. Provincial governments are also responsible for the management and maintenance of premises identifiers within their jurisdictions.

In China, regulation of food safety historically cascaded from national, to ministerial, provincial, and then to local levels. Before the enactment of the 2009 Food Safety Law, there were more than 2,000 national standards; 2,900 industrial standards; and 1,200 local standards on food, food additive, and food-related products. A national food safety standard system has been established, and is supplemented by industrial standards, local standards, and enterprise standards (USDA/FAS 2011b).

4. If there are no specific governmental regulations, are there voluntary practices by industry?

Voluntary traceability practices exist in OECD countries other than those of the EU, which has mandatory traceability of all food, feed, and food-producing animals. Industry-led programs generally involve producers and processors establishing traceability programs and practices for their commodities in order to strengthen food security, inventory control, and trade efficiency. Although they are not regulatory requirements, the industry-led programs often precede or are intended to mitigate the introduction of government regulations. These industry-led programs are summarized below to provide additional context and the relative rankings are summarized in Table 5.

In Canada and the United States, there are voluntary practices for the traceability of processed food products, through lot and package identification. The Canadian Produce Marketing Association (CPMA) and the U.S. Produce Marketing Association (PMA) are leading an approach through their Produce Traceability Initiative (PTI). The PTI program uses the Global Fruit and Vegetable Traceability Implementation Guide and tools established by GS1 to trace products in the fresh fruit and vegetable industry supply chain (CPMA 2014; Produce Traceability). The PTI recommends using standardized GS1 codes and produce codes set by the International Federation for Produce Standards (IFPS; PMA 2014b; Fresh Connection China summit). Although these are not regulatory requirements, they put Canada and the United States on a similar footing.

The PMA is focusing not only on North America, but is expanding its scope to include other countries to lead broader initiatives for global produce traceability. Currently, the association has offices and produce traceability initiatives in several countries. PTI guidelines are ongoing in Europe, Australia and New Zealand, and Brazil (PMA 2014a; Global).

In the United States, traceability guidelines are being established by 3 other key food sectors: (1) beef and poultry, established by 6 national meat associations along with GS1 (Meat and Poultry Data Standards 2010); (2) seafood, established by National Fisheries Institute and GS1 (U.S. Implementation Guide 2011); and (3) dairy, deli, and bakery, established by the International Dairy Foods Association, International Dairy-Deli-Bakery Association, and GS1 (U.S. Implementation Guide 2013). These industry-led requirements, as with PTI, are intended as voluntary guidelines for their sectors.

On July 2007, Decree No. 503 of the State Council of the People's Republic of China (Promulgating the Special Regulations of the State Council on Strengthening the Supervision and Administration the Safety of Food and Other Products) required that the seller establish an inspection system for the received products, and verify the business license of the supplier and the product's certification and identifier. The seller must establish a product purchasing ledger to record product name, specification, quantity, supplier's contact information, and time of purchasing. The wholesaler must establish a product sales ledger to record product variety, specification, quantity, and product flow. Finally, food wholesale and sale operators must establish and retain a purchase and sales ledger and identify food products and sales flow for at least 2 years.

In 2009, the "Food Safety Law of PRC" and its implementing regulation was promulgated, requiring food producers to establish a purchase inspection record system and a food delivery inspection record system, and accurately record legal matters, or retain relevant notes of the purchase or sale. Food safety management of the production process should also be accurately recorded. Food operators are required to establish records of the source of the products and sales. The retention period of notes and records is not less than 2 years (Liu 2010)

In 2010, the Chinese Ministry of Commerce (MOFCOM) introduced the Meat and Vegetable Distribution Traceability System and Safe Meat Service to track the movement of livestock from slaughterhouses and wholesale markets to retailers. The program is aimed at preventing illegal operations and adulterated food from entering the supply chain between the producer and retailer. The Service also acts as a form of tracking tool in the event of contamination and need for recall. The voluntary program was initiated in 2010, and by 2013 was tested in pilot studies in 20 provinces and cities including Beijing, Shanxi, Jiangxi, Qingdao, Hangzhou, Yinchuan, and Nanjing (MOFCOM 2013). The pilot system uses barcodes and RFID tags to transmit lot/batch information to a central database. Authorities frequently check that retailers have updated the database when shipment is received. Although the tracking system is built to track product only from slaughterhouse and wholesale to retail, it helped identify and close some unlicensed slaughterhouses (Reuters 2013). The system does not track from the origin of the food source, that is, farms.

Also, in September 16, 2010, the State Council of the People's Republic of China issued the circular "Further Strengthening the Work of Dairy Quality and Safety," to "improve the dairy traceability system" and "implement electronic information traceability system." In November of the same year, the "Review of permit conditions for infant formula milk powder production (2010 edition)" and "Review of permit conditions for dairy production (2010 edition)" were revised (AQSIQ 2010), again clearly requiring dairy enterprises to establish an "electronic information traceability system" and standardize the quality control information on key processes or critical control points that needed to be recorded (Liu 2010).

As announced by CFDA in December 2013, the CFDA will establish the product traceability system nationally beginning in 2014, requiring all food companies to establish the traceability system. Powdered infant formula milk, dairy products, meat, and alcohol will be the first food sectors to implement the system, which will gradually be extended across the country (Chemical Inspection and Regulation Service, January 2014).

Table 5–Rankings of countries based on voluntary traceability practices.

Country	Ranking
Australia	Progressive
Austria	N/A (traceability is mandatory in accordance with EU 178/2002)
Belgium	N/A (traceability is mandatory in accordance with EU 178/2002)
Brazil	Progressive
Canada	Progressive
China	Moderate
Denmark	N/A (traceability is mandatory in accordance with EU 178/2002)
Finland	N/A (traceability is mandatory in accordance with EU 178/2002)
France	N/A (traceability is mandatory in accordance with EU 178/2002)
Germany	N/A (traceability is mandatory in accordance with EU 178/2002)
Ireland	N/A (traceability is mandatory in accordance with EU 178/2002)
Italy	N/A (traceability is mandatory in accordance with EU 178/2002)
Japan	Progressive
The Netherlands	N/A (traceability is mandatory in accordance with EU 178/2002)
New Zealand	Progressive
Norway	N/A
Russian Federation	No data
Sweden	N/A (traceability is mandatory in accordance with EU 178/2002)
Switzerland	N/A
United Kingdom	N/A (traceability is mandatory in accordance with EU 178/2002)
United States	Progressive

Table 6–Rankings of countries based on breadth of products regulated for traceability.

Country	Ranking
Australia	Moderate (livestock only)
Austria	Progressive
Belgium	Progressive
Brazil	Moderate (livestock only)
Canada	Moderate (cattle, swine regulation)
China	Regressive
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Progressive (domestic beef, rice)
The Netherlands	Progressive
New Zealand	Moderate (livestock only)
Norway	Progressive
Russian Federation	No data
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Regressive

The regulations identified above show that traceability requirements mainly are required at the trading event; there are no specific requirements for internal data collection. Also, there are no traceability requirements for specific data collection at processing.

There are other industry standards in China for fish and fishery products (standard published in 2013), and fruits and vegetables (standard published in 2012), as noted above. In addition, there is a national standard (government guidelines) with regards to traceability system design and implementation (published in 2010) that provides direction on development of food traceability within food companies.

5. What products or commodities are being regulated for traceability?

In Europe, EU legislation 224/2009 addresses traceability for all food and feed products. This legislation is considered superior to that in other OECD countries where legislation is confined to specific products and commodities. This can be seen in the rankings on Table 6.

In the OECD countries studied, animal traceability was the focus of traceability regulations, and the regulations were mainly based on the identification and tracking of livestock from birth to slaughter, except for EU and Japanese regulations which have expanded scope. EU legislation requires that livestock be identified and labeled from birth, through the processing of meat cuts, to the final sale of products. Similarly, Japanese regulations require the same unique identification number to be carried from live animal, to the meat cuts, and to the label of final products for consumers' reference. In addition, Japan requires traceability of rice and rice products.

In these OECD countries other than the EU, government regulations for the traceability of other commodities such as seafood, fresh produce, poultry, and hogs, and processed products are still either under development, or are being addressed by industry-led voluntary practices. Guidelines are being established by industry associations and made available to industry for developing traceability systems. For example, the Japanese Handbook for Introduction of Food Traceability Systems is a set of guidelines for the traceability of commodities such as fruits and vegetables, shellfish, eggs, and farmed fish. It is not known, however, whether these guidelines have been adopted and implemented throughout the Japanese food industry.

In China, ISO 22005–2007 was adopted in 2009 into a national standard—GB/T 22005–2009: "Traceability in the feed and food chain: General principles and basic requirements for system design and implementation." And in 2010, the technical document "Traceability in the feed and food chain: Guideline on system design and implementation" was published. While not strictly regulations, in the Chinese economy these requirements take on the meaning of 'government guidelines.'

6. What kinds of identifiers are being used for tracking/registering of imports (such as ear tags, barcodes, RFID)?

Identifiers used in the traceability of food products vary from simple hand-printed identification, to labels and marks on containers, to more technically-advanced tools such as RFID tags and machine-readable barcodes. Unique identification numbers (UID) can be stored and presented and transmitted in a variety of ways, including ear tags for live-

Table 7–Rankings of countries based on use of identifiers for tracking/registering of imports.

Country	Ranking
Australia	Progressive
Austria	Progressive
Belgium	Progressive
Brazil	No data found
Canada	Progressive
China	Progressive
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Progressive
The Netherlands	Progressive
New Zealand	Progressive
Norway	Progressive
Russian Federation	No data found
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Moderate

stock, printed human-readable data, barcodes, 2D barcodes, and electronic RFID. Also, in combination with identifiers, commercially available hardware and software can ease data recording, storing, and retrieving (Welt and Blanchfield 2012). Table 7 shows the rankings of countries based on the use of these identification methods and tools for traceability.

Although there may be a variety of identifiers used for different products, the information available and accessible from the countries studied in this activity shows that the most widely-used identifiers for packaged products are GS1 and proprietary barcodes, used on individual as well as on logistics and shipping units, and ISO ear tag standard identifiers for tracing livestock. Access to information beyond livestock traceability was limited in many of the studied countries due to the fact that traceability of other food products and commodities (e.g., grains, fresh produce, and seafood) is supported through private companies or industry-led initiatives. Therefore, privacy and intellectual property concerns may limit access to information about usage. Even though animal identification does not equate to traceability, it does require a basic set of information to make traceability possible.

In EU nations, livestock ear tags are mainly used for identifying animals prior to slaughter; in addition, each animal must be "tagged" with a stamp showing the traceability code of the slaughterhouse. The tools (ear tags, animal passports, location identifiers, and bar codes) used may vary from one EU country to another but must carry the same essential data. The Trade Control and Expert System (TRACES) provides a central database for tracking the movement of animals and animal products both within and outside the EU. In the event of a disease outbreak, TRACES ensures that all potentially affected animals can be quickly identified and that authorities can take appropriate measures (EC 2007). Operators or organizations marketing European or imported beef are obliged to label the beef at all stages of the marketing process. For example, minced beef must have a reference number or code on the label that establishes the link between the meat and the animal (or group of animals) from which the final product was derived (EC Regulation No. 1760/2000).

Regarding packaged products, Universal Product Code (UPC) barcodes and serial shipping container codes (SSCC) are used internationally for recording package unit, logistical/shipping unit, and lot and batch identification. These identifiers can be transferred to bar code symbols that are commonly used where scanning with an electronic device is possible. The EU uses the Combined Nomenclature (CN) for the customs classification of goods. The CN 8-digit code numbers are based on the Harmonized System (HS) nomenclature: the first 6 digits refer to the HS headings; the 2 subsequent digits represent the CN subheadings. The EU's on-line "Taric" customs database can be consulted to look up commodity codes and relevant import duties. The EU's 2013 Tar GS1 coding system has become more prevalent in grocery market chains (USDA/FAS 2013a).

Norway is a member of the European Economic Area (EEA); thus, many of the Norwegian food requirements on food safety, labeling, and traceability are subject to standardized EU rules which have been incorporated into Norwegian legislation through the EEA cooperation (USDA/FAS 2013b).

All food exporters to the United States must register with the U.S. FDA database and have a U.S. agent. The labels and bar codes used on the packaging of some food products may help with tracing products. For animal identification and traceability, the United States requires imported cattle to be identified with ear tags. As with the EU, most packaged goods sold in the United States are identified with UPC codes through industry practice and agreements, which are not mandatory government regulation.

In Canada, the CFIA has the authority to approve or revoke livestock tags. The tags must have the official logo of the responsible administrator and a UID number that follows the ISO 11784 standard format (i.e., 15 digit-number). The first 3 digits express the country code, in accordance with the ISO 3166 standard (i.e., "124" for Canada), followed by 3 digits, that are managed by the CFIA and which may correspond to systems where animal identification numbers were allocated (e.g., animal breeds). The last 9 digits provide a unique identifier for each individual animal (CFIA 2013b). However, to trace food products, detailed information on labels or packages is required, and the information must meet the requirements of the Canadian Consumer Packaging and Labelling Act and Regulations and other Acts and regulations for specific food commodities (CFIA 2014c).

Australia has very strict quarantine requirements for imported food and agricultural products. Import permits and certifications as well as detailed information are required for the majority of food and agricultural products entering the country. The Australian NLIS utilizes a single national centralized database maintained by Meat and Livestock Australia where all animals are identified (with standard RFID tags) and their movement is traced using RFID. Australian consumers are not able to trace meat products back to individual livestock, but there is ability to track finished meat products back to processor lot numbers.

New Zealand and Switzerland are amongst the world leaders in the tracking of animals from birth to slaughterhouse (USMEF 2011). The Animal Tracing Database (BDTA) in Switzerland was created in December 1999, following the outbreak of mad cow disease (BSE), with the purpose of tracing the movement of livestock, primarily cattle. Switzerland labels animals upon birth with 2 registered ear bands, allowing tracing of the animal's path, through its individual number, back from the meat product at the shop counter, to the slaughterhouse, and to the farm on which the animal was born. Ear tags include country of origin and unique animal identification and a corresponding barcode designed to be compatible with EU requirements (MAF 2009). In 2011, the Swiss government expanded the tracking to "livestock" horses, as

well, meaning that all horses born in or imported into Switzerland could possibly enter the food chain, and thus must be identified by electronic microchip and registered with the BDTA (Leste-Lassere 2013).

New Zealand's National Animal Identification and Tracing Act (NAIT) uses RFID technology with a national database to trace animals from birth to slaughter or live export. When importing cattle, buffalo, and deer, the importer must follow regulations by NAIT and the Ministry of Primary Industries (MPI) which requires that ear tags remain in the animal's ear until slaughter. If the NAIT or MPI ear tag is altered or removed without a valid reason, it is considered an offence under the Biosecurity Act of 1993. The numbers associated with each ear tag (NAIT visual and RFID) must be recorded and verified on the veterinary certificate and laboratory reports. In some cases, where microchips are required, the microchip number must be shown on all accompanying certifications and documents and it must be in accordance with ISO standards 11784:2001 and 11785:2001. Otherwise, the importer must ensure that an electronic reader is available as well so that the MPI Inspector is able to identify the animal at any stage (Ministry for Primary Industries).

Japan requires all domestically produced beef to be traceable from consumer back to farm of origin. Japan also established a traceability system for beef to allow consumers to trace beef on the internet with a 10-digit code (Frohberg and others 2006). All cattle are required to be tagged, and animal movement must be reported to the government body that maintains the database. Cattle ID numbers and packaged meat products are coded using the GS1-128 barcode system. A health certificate issued by the government authority of the exporting country is required for flesh and organs of livestock (cattle, horses, hogs, sheep, and water buffalo) and poultry (chickens, ducks, and turkeys), or products made from their meats (ham, sausage, for example).

China requires food producers, processers, packers, and retailers to test all the inputs and outputs of their system and to keep the records for at least 2 years (Zhang and others 2012). China uses ear tags with 2D barcodes to identify pigs, cattle, and sheep (Ben-hai and others 2010). At this time, there is no mandatory national livestock identifier used in China. Imported packaged food products generally are required to follow the same global GS1 standards established by GS1 China, unlike other GS1 affiliates, since it operates as a branch within the national government.

No data concerning specific identifier regulations were found for Brazil or the Russian Federation.

7. Are GFSI benchmark standards recognized?

GFSI benchmark standards are widely recognized around the world today for food safety verification through third party auditors. Well-known auditing bodies that certify companies to GFSI standards are internationally recognized, and their certification programs are customized to audit food companies in different countries. For example, the GFSI auditing firm SGS is located in many countries throughout the regions of Europe, North and South America, and Asia. GFSI schemes are considered international standards that can be used as proof of adequate food safety precautions by a company for international business purposes. Countries with different regulatory systems may choose to rely on the veracity of supplied information when a business is certified by the relevant GFSI standards for a specific commodity. Most GFSI standards are recognized by food operators in most of the countries studied in this research. Table 8 summarizes the relative rankings of countries concerning the use of GFSI requirements and certifications for food safety and traceability purposes.

GFSI schemes provide the means for a third party verification program and go beyond what regulatory agencies in many countries require in terms of traceability. Certification under GFSI regulations requires that a company must be able to demonstrate that its traceability system is effective and functioning by presenting past traceability and mock recall exercises and actually performing a traceability exercise with the auditor at the time of audit. By following the trail of documentation, the recall/traceability team must be able to trace raw ingredients, products made using those items, and the final products that are being sent to the customer or distribution center. In addition, one of the GFSI schemes—the British Retail Consortium (BRC)—requires a mass balance calculation (inputs, transformations, and output weights) to be done during the audit (BRC Global Standard for Food Safety, July 2011). The calculation verifies that the amounts of certain lots of ingredients used to make finished product coincide with the documented output. At a minimum, mock traceability exercises must be done annually. Unsatisfactory results on major sections of the standard (such as traceability) require corrective actions, re-audit, and/or denial of certification until a subsequent audit is acceptable.

The rankings for this portion of the research were based on the availability of auditing companies that are certified to conduct audits and verify corporate performance on food safety and traceability practices, and the length of time these bodies were certified for these audits.

8. Are GS1 services (such as traceability tools and coding standards) available?

GS1 established standardized supply chain systems that are being used globally, and this has enabled a more harmonized method of identifying and coding products. GS1 identification standards are most commonly recognized in the identification of retail products. GS1 codes include information such as location, company, trade unit data, and type of product. The use of GS1 identification standards for products traded domestically or internationally has enabled broader recognition and traceability of products, and has significantly streamlined electronic commerce. While not strictly a regulatory item, GS1 standards are nevertheless often associated with uniform requirements and implementation of traceability schemes and systems.

In addition, GS1 has expanded to aid traceability of food products, and several case studies have successfully increased the traceability of fresh food. The case studies range in complexity from the simple application of GS1 128 coding (an application standard within code 128 high-density barcode symbology) on labels of food products (e.g., a dairy processor in The Netherlands), to a more advanced downstream and upstream tracking system using internet technology and the Global Traceability Standards established by GS1 (e.g., a poultry processor in France). In these case studies, it was concluded that the implementation of a traceability system and GS1 standards help improve the efficiency of a company's supply chain management.

GS1 has established the Global Traceability Conformance Program (GTC) to help companies implement traceability. Some of the objectives of the program include ensuring compliance with the regulations, HACCP food safety requirements, and GFSI standards demanded by such bodies as the British Retail Consortium (BRC), International Food Standard (IFS), and Global Good Agricultural Practices (Global GAP). The GTC also fulfills traceability

Table 8–Rankings of countries based on availability of GFSI auditing bodies.

Country	Major GFSI accreditation bodies	Ranking
Australia	Société Générale de Surveillance (SGS), Joint Accreditation System of Australia and New Zealand (JAS-ANZ)	Progressive
Austria	SGS	Progressive
Belgium	NSF, SGS, Belgian Accreditation Body (BELAC)	Progressive
Brazil	SGS	Progressive
Canada	NSF, SGS	Progressive
China	NSF, SGS	Moderate
Denmark	SGS, Danish Natl. Body for Accreditation (DANAK)	Progressive
Finland	SGS, Finnish Accreditation Service (FINAS)	Progressive
France	NSF, SGS, Association Chargée de l'Accréditation des Laboratoires, Organismes Certificateurs et d'Inspection (COFRAC)	Progressive
Germany	NSF, SGS, Deutsches Akkreditierungssystem Prüfwesen GmbH (DAP)	Progressive
Ireland	NSF, SGS, Irish Natl. Accreditation Board (INAB)	Progressive
Italy	NSF, SGS, Sistema Nazionale per l'Accreditamento degli Organismi di Certificazione e Ispezione (SINCERT)	Progressive
Japan	NSF, SGS	Moderate
The Netherlands	SGS	Progressive
New Zealand	SGS, JAS-ANZ	Progressive
Norway	SGS, Norwegian Accreditation (NA)	Progressive
Russian Federation	No data	No data available
Sweden	SGS, The Swedish Board for Accreditation and Conformity Assessment (SWEDAC)	Progressive
Switzerland	SGS, Swiss Accreditation Service (SAS)	Progressive
United Kingdom	NSF, SGS, United Kingdom Accreditation Service (UKAS)	Progressive
United States	NSF, SGS, American Natl. Standards Institute (ANSI)	Progressive

Table 9–Rankings based on extent of GS1 services used in the country.

Country	Ranking
Australia	Progressive
Austria	Progressive
Belgium	Progressive
Brazil	Progressive
Canada	Progressive
China	Moderate
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Progressive
The Netherlands	Progressive
New Zealand	Progressive
Norway	Progressive
Russian Federation	Regressive
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Progressive

requirements of major governmental food regulations such as the EU's EC 178-2000 and Japan's Food Sanitation Law, as well as other regulations.

GS1 is recognized by its development and management of global standards for coding identification of food products as well as nonfood consumer products in different retail sectors, health care, transportation, and logistics. The use of GS1 standards for coding and tracing products across different regions of the world would promote a more efficient traceability system globally. On January 14, 2014, the European Commission (EC) acknowledged the use of GS1 Standards as a best practice in addressing supply chain traceability needs in nonfood consumer products (GS1 International Media Release, January 2014).

GS1 organizations and offices are present in all 21 OECD countries studied in this report. Offices of GS1 representatives provide services, training, and collaboration with local governments and companies to initiate various projects to improve supply chain management and traceability. In some regions, such as Europe, North America, and Japan, GS1 offers extended services and projects in traceability and recalls. Table 9 shows the ranking of countries regarding the extent and use of GS1 standards for traceability.

9. Is there an electronic database system used for monitoring imports/exports and their traceability? Are these systems accessible by importing countries?

Most current national-level databases used for the traceability of food products are developed for livestock registration, identification, and movements. The EC established the EU TRACES network which notifies, certifies, and monitors imports, exports, and trade in animals and animal products. Members of EU countries as well as other countries of the world are able to assess the database for animal identification and movement.

There are also several animal-tracking databases that have been or are in the process of being established by individual countries for use at the domestic level: Denmark's Central Husbandry Register (CHR), Germany's Herkunftssicherungs-und Informations System für Tiere (HIT), Ireland's Animal Identification and Movement (AIM) System, France's National Livestock Database BDNI, and the UK's Cattle Tracing System (CTS). Furthermore, the EU's Rapid Alert System for Food and Feed (RASFF) provides a reporting and alert system for risks related to food and feed products that enables the exchange of information among EU Member States.

Australia and New Zealand monitor their livestock through their NLIS database and National Livestock Database (NLDB), respectively. Canada monitors livestock identification and movement through their CCIA that oversees the CLTS. Information is available to processors, importers, and regulators that register and need to retrieve information about livestock identification and movement.

Although EU legislation exists for the traceability of all food and feed products from farm to fork, no product is monitored by a network of electronic reporting and recording systems as complete or developed as that which is used to track livestock.

Canada and the United States share a similar ranking for this indicator. Although Canada has specific animal traceability regulations for some livestock (notably cattle, bison, and, more recently, hogs), it does not yet have a complete national system. The

Table 10–Rankings based on electronic livestock tracking systems.

Country	Ranking
Australia	Progressive
Austria	Progressive
Belgium	Progressive
Brazil	Progressive
Canada	Regressive
China	Regressive
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Progressive
The Netherlands	Progressive
New Zealand	Progressive
Norway	Progressive
Russian Federation	No data
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Regressive

Table 11–Rankings based on comprehensiveness of labeling.

Country	Ranking
Australia	Progressive
Austria	Progressive
Belgium	Progressive
Brazil	Progressive
Canada	Progressive
China	Moderate
Denmark	Progressive
Finland	Progressive
France	Progressive
Germany	Progressive
Ireland	Progressive
Italy	Progressive
Japan	Progressive
The Netherlands	Progressive
New Zealand	Progressive
Norway	Progressive
Russian Federation	Regressive
Sweden	Progressive
Switzerland	Progressive
United Kingdom	Progressive
United States	Progressive

United States has yet to regulate requirements for animal tagging and premises registration at the national level.

The traceability of other commodities such as grains, fresh produce, seafood, processed products, and feed is only available through private or industry-led initiatives, which incorporate batch or lot identification, business record keeping, and inventory control or supply-chain management systems. None of the countries in the study have an electronic tracking system for all commodities. Therefore, the rankings pertain only to the availability and accessibility of national livestock electronic database systems.

Table 10 shows the ranking of countries with regards to the existence and use of livestock tracking systems in those countries.

10. What information on packaging labels is available for the consumer to understand traceability?

Labeling is a crucial part of product identity and functions not only as a method of conveying product information to trading partners and consumers, but also serves as a key traceability tool at the time of recall or other food emergency. Including specific elements such as product identification, manufacturer and importer's information, and the product's country of origin on the product label facilitates the tracing of products in the retail sector. This information also enables the consumer to recognize specific products at the time of recall due to foodborne illness, plant and animal health disease, or possible fraud in the supply chain. Product labels are the most convenient way and familiar means for consumers to obtain product information and recognize suspect products. Labeling laws and regulations are enforced in all the OECD countries considered in this study, with both domestic and imported products addressed by the labeling regulations set up by each country. Table 11 provides the ranking of countries concerning the availability and comprehensiveness of package labeling.

Labeling law in the EU exists as follows: Directive 2000/13/EC for the labeling and advertising of foods, EC No. 1760/2000 for beef products, and EC 104/2000 for fish products. EU Member Nations follow these labeling regulations for domestic and imported products across the region. The regulations of Norway and Switzerland are based on EU labeling legislation, and products are expected to meet the same EU standards. The labeling requirements related to traceability are as follows, for pre-packaged foods: name of the food, list of ingredients (highlighting allergens), quantity of certain ingredients, nutrition declaration, net quantity, date of minimum durability, any special storage conditions and/or conditions of use, and the name or business name and address of the food business operator under whose name the food is marketed. If that operator is not established in the EU, the name and address of the importer and country of origin or place of provenance in accordance with the provisions of Article 26 must be listed. In addition, alcoholic strength by volume for beverages containing more than 1.2% by volume of alcohol must be noted.

Labeling requirements related to traceability for non prepackaged food differ greatly, as the declarations listed under Article 9 are not mandatory, with the exception of allergens. However, Member States may adopt national measures to establishing that information which is mandatory for prepackaged food under the new EU rules is also mandatory for non prepackaged food.

Additional mandatory labeling requirements for specific types or categories of food are also required of certain foods: foods with modified atmosphere packaging, foods containing sweeteners, foods containing liquorice, beverages with high caffeine content or foods with added caffeine, foods with added phytosterols or phytosterol esters, frozen meat, frozen meat preparations, and frozen unprocessed fishery products.

France requires the date of minimum shelf-life (DLC) for perishable products or the date of optimal usage (DLUO) for nonperishable products, and the name and address or EU identification number in the same area of the label. Products exempt from indicating the DLC or DLUO include: fresh fruits and vegetables, wines and spirits, alcoholic beverages with an alcoholic content equal to or greater than 10.5% by volume, vinegars, sugar, confectionery items, and live shellfish intended for raw consumption.

All mandatory food information must be provided in a language that is easily understood by the consumers of the Member State where the food is marketed. Country-of-origin labeling is mandatory for fresh beef, fruits and vegetables, honey, olive oil, and in cases where the absence of such labeling may mislead the consumer.

The key elements of the new EU food labeling rules (effective December 13, 2014) include the mandatory nutrition declaration, and the extension of country-of-origin labeling to fresh meat

derived from swine, sheep, goat, and poultry. Indication of the date of freezing on unprocessed frozen meat and fishery products is also mandatory.

Operators or organizations marketing European or imported beef are obliged to label the beef at all stages of the marketing process and must include the following information: reference number or code establishing the link between the meat and the animal (or group of animals) from which the product was derived; information covering both "Slaughtered in" (country where slaughter took place and license number of the slaughterhouse) and "Cutting/cut in" (country where cutting was performed and license number of the cutting plant); and country where the animals were born and fattened/bred.

Fishery and aquaculture products must have the following labeling information: commercial designation of the species, production method (caught at sea or in inland waters or farmed), and the catch area. These requirements do not apply to small quantities of products disposed of directly to consumers by either fishermen or aquaculture producers. Purchased quantity (e.g., pallet, and box) must include the following information: name, information on the producer, packer or vendor, and shelf-life.

Brazil also has established its Brazilian Consumer Protection Law that is applied to both domestic and imported products and requires that labels must be in Portuguese. The Brazilian food regulation is fairly progressive; food and beverage labels must provide the consumer with correct, precise, clear, and legible information about the product (USDA/FAS 2011a). The following labeling requirements are mandatory: technical name according to classification, brand, quantity, list of ingredients, country of origin, producer contact information (complete name and address), importer information (corporate name, address, corporate ID), date of production, date of product expiration, lot number, storage care, instructions for use or preparation (if necessary), the expression "Contains Gluten" or "Does Not Contain Gluten" clearly visible, and nutritional information.

Similarly, Australia, New Zealand, Japan, China, Canada, the United States, and Russia require domestic and imported products to meet their established labeling regulations with product labels available in the language of the importing country.

Food labeling regulations in Australia and New Zealand fall under Food Standard 1.2.1—Labeling and Other Information Requirements. Food imported into Australia must meet this standard; and, importers are responsible for ensuring the food they import meets all the requirements of the code (FSANZ 2011). Similarly, food imported into New Zealand must meet specific labeling requirements. One difference between the requirements of Australia and New Zealand is that the country of origin statement is a voluntary practice in New Zealand. The labeling requirements in Australia and New Zealand are as follows: name/description of food, lot identification, name and business address of supplier, mandatory warning, and advisory statements and declarations, ingredients, date marking, directions for use and storage, nutrition information, country-of-origin labeling (Australia only), health and related claims, special purpose foods (including amino acid-modified foods; New Zealand only), percentage declaration, novel food, genetically modified food label, and an indication of irradiation.

Common mandatory elements required on labels of processed or packaged food of all OECD countries are: product name, importer/manufacturer name and business, batch or lot information when applicable, date code information, list of ingredients, and country of origin (except New Zealand's mandatory requirement).

The EU's and Japan's beef labeling laws require that identification number of cattle and meat cuts used for producing a product must appear on the label of the product (or at nearby location) at the point of sale.

Canadian labeling follows the country's Consumer Packaging and Labelling Regulations, Canadian Agricultural Products Act, Meat Inspection Act, Food and Drugs Act, and Fish Inspection Act, which require the following: common name, date marking, list of ingredients (highlighting allergens), name and address, net quantity, nutrition labeling, bilingual labeling, and country of origin. All prepackaged food products sold in Canada are required to be labeled with the name and address of the company responsible for the product (i.e., the importer or manufacturer). When a food product is manufactured entirely outside of Canada, the label must show that the product is imported. In Canada, it is mandatory that the country of origin is stated on some specific imported prepackaged products (such as imported meat products, dairy products, honey, maple products, poultry, eggs, fresh and processed fruit and vegetable products, certain alcoholic beverages [wine and brandy], and some fish and shellfish products).

China is developing its food labeling regulations through 2 national standards: GB 7718-2011, the General Rules for the Labeling of Prepackaged food; and GB 28050-2011, the General Rules for Nutrition Labeling of Prepackaged foods (China CRS 2014). The GB 7718-2011 is an updated version of GB 7718-2004. The GB 7718-2011 already requires mandatory information such as food name, manufacturer's information, and date code information (USDA/FAS 2011b). The final version was issued by the Ministry of Health (MOH) on April 20, 2011, and was implemented on April 20, 2012 (China CRS 2014). The General Administration of Quality Supervision, Inspection, and Quarantine (AQSIQ) acts as the enforcement body for this national standard. The GB 7718-2011 and GB 28050–2011 describe the standardized requirements on prepackaged food and nutritional label information of the food products. Administrative regulation on the inspection and supervision of labeling of imported and exported prepackaged food, addressed by AQSIQ Notice 27, was issued by AQSIQ on February 27, 2012 and implemented on June 1, 2012 (China CRS 2014). According to the regulations, importers must make sure that prepackaged food labels meet the requirements of Chinese authorities and they must be able to provide required documentation (such as Chinese translation of the label and information about the importer).

Labeling requirements in China are as follows: name of foods, list of ingredients, net weight and configuration, address and contact information of manufacturers and/or distributors, date of manufacture and date of minimum durability, conditions for storage, food production license number, product code (domestic products), and nutritional information. Imported and exported products going through Chinese Customs for the first time require: Chinese-specific label, original label and translated version, nutrition test reports, business license of importer, distributor or Chinese agent, and other documentation if there are any claims on the label.

Japan's food regulation related to labeling centers around the Food Sanitation Law, JAS (Quality Labeling Standard), and other national laws (such as the Nutrition Improvement Law; Japan Retail News 2014). Japanese regulation requires that in addition to basic product and manufacturer information, imported products must also carry country-of-origin information. In accordance with the Beef Traceability Law, domestic beef products are required to be labeled with cattle identity number or lot number at retail

Table 12–Overall world ranking scores of countries based on comprehensiveness of traceability regulations for domestic and imported products.

Country/Question	1	2	3	4	5	6	7	8	9	10	Aggregate Score
Australia	M	M	P	P	M	P	P	P	P	P	Average
Austria	P	P	P	P	P	P	P	P	P	P	Superior
Belgium	P	P	P	P	P	P	P	P	P	P	Superior
Brazil	M	M	P	P	M	N	P	P	P	P	Average
Canada	M	M	M	P	M	P	P	P	R	P	Average
China	R	R	M	M	R	P	P	M	R	M	Poor
Denmark	P	P	P	P	P	P	P	P	P	P	Superior
Finland	P	P	P	P	P	P	P	P	P	P	Superior
France	P	P	P	P	P	P	P	P	P	P	Superior
Germany	P	P	P	P	P	P	P	P	P	P	Superior
Ireland	P	P	P	P	P	P	P	P	P	P	Superior
Italy	P	P	P	P	P	P	P	P	P	P	Superior
Japan	M	P	P	P	P	P	M	P	P	P	Average
Netherlands	P	P	P	P	P	P	P	P	P	P	Superior
New Zealand	M	M	P	P	M	P	P	P	P	P	Average
Norway	P	P	P	P	P	P	P	P	P	P	Superior
Russian Federation	N	N	N	N	N	N	N	R	N	R	Insufficient Data
Sweden	P	P	P	P	P	P	P	P	P	P	Superior
Switzerland	P	P	P	P	P	P	P	P	P	P	Superior
United Kingdom	P	P	P	P	P	P	P	P	P	P	Superior
United States	M	M	M	P	R	M	P	P	R	P	Average

P Progressive M Moderate R Regressive N No Data

stores, as well as at restaurants. Cattle ID number and packaged meat products are coded with a GS1-128 barcode system. Labels must list the product name, date of minimum durability or best-before date, name and address of the importer, additives used, and whether any allergenic substances are present. Imported processed food must include the following: product name, list of ingredients, net contents, the best-before date or date of minimum durability, preservation method, country of origin, and the importer's name and address. Labels of imported fresh food must show product name and country of origin. Products that were previously frozen and subsequently thawed must use the word "thawed." Products that were deliberately cultivated must use the word "cultivated." Cattle ID number or lot number are mandatory on a meat package sold to consumers at retail establishments and restaurants.

Prepackaged food labeling requirements of the Russian Federation address most of the same items that are addressed in other countries. However, Russia lacks a requirement for indicating country of origin. Also, it is optional for imported products to provide technical documentation by which the products can be identified. The labeling requirements are as follows: product name, data about the manufacturer (including name, country, and address of producer), the organization authorized to accept claims from consumers, trademark, and net weight (or volume or quantity), composition (ingredients), nutritional value based on the specificity of the product, storage conditions, use-by date or shelf-life expiration date, and the date of production and packaging. Also, regulatory or technical documents by which the products can be identified, which are optional for imported products, with the confirmation of conformity stamp are required.

U.S. FDA regulations make food labels mandatory in the United States for most prepared foods. These labels must include the following: name of food, net quantity, ingredient list, nutritional labeling, allergen warnings, and the name and place of business of the manufacturer, packer, or distributor. Nutrition labeling for raw produce (fruits and vegetables) and fish is voluntary (referred to as "conventional" foods). A statement of the country of origin on labeling for imported foods is not required by the Federal Food, Drug, and Cosmetic Act, but it is a requirement of the U.S. Customs and Border Protection Service.

Discussion

To develop an overall world ranking, country rankings for each category were aggregated, and each country was given a total, overall world ranking score of either "Superior," "Average," or "Poor." Table 12 provides the aggregate ranking of the countries in this project.

EU countries—Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Sweden, the United Kingdom, and the European Free Trade Association (EFTA) countries (Norway and Switzerland)—all scored as Superior. These countries follow the stipulations of EU legislation 178/2002 governing the mandatory traceability of food, feed, and food-producing animals. Also, in accordance with EU beef labeling regulations, final beef product is traced to initial cattle and meat cuts. EU-based legislation is applied not only to domestic products but also to imported products among the EU countries as well as other exporting countries. The comprehensive regulations for the traceability of all food products (domestic and imports) and farm-to-fork beef products (domestic and imports) have earned Norway and Switzerland a score of Superior. All the European countries studied accept internationally recognized GFSI benchmark schemes and the GS1 coding system, making their markets more accessible for international trade.

Japan scored as Average. The country is at the advanced stage regarding the traceability of beef products from farm to fork, with mandatory regulation on package labeling that includes the identification of original cattle. However, labeling regulation is currently only applicable to domestic beef products. Rice traceability legislation exists for domestic and imported products and several guidelines for the traceability of other commodities have been established by the Japanese government. Other traceability requirements are in development.

Canada scored as Average on traceability. Although there are no national regulations in Canada on farm-to-fork traceability at this time, the Canadian government has focused on livestock identification and processed meat traceability through its Food Safety Enhancement Program (FSEP) Bullet F 1.1.1: Recall Plan. Among other requirements for recall, this plan requires that every company is equipped with methods to trace the product (including raw ingredient, pre-mix ingredients, and rework) by maintaining product identification throughout the process until final packaging (CFIA 2013c). However, Canada lacks specific legislation on the traceability of other commodities and it does not have a national traceability system, although there are efforts and pilot projects at the industry and provincial levels for the traceability of products such as hogs, dairy, poultry, and egg products.

Australia, Brazil, New Zealand, and the United States also scored as Average. These countries have traceability regulations pertaining to livestock identification and movement, and generally lack regulations on other agricultural commodities. However, these countries do have identification and labeling regulations on packaged food products. Despite the passage of the FSMA and the opportunity to strengthen traceability, the United States is still lacking regulations dealing with national traceability of food products in general.

China scored as Poor since its traceability system is still under development, and traceability is largely unregulated. Although livestock identification has become mandatory, and significant progress has been made on establishing guidelines in specific sectors, the country is still in the early stages of implementing a system of traceability for other products at the national level.

Little information is available for determining traceability requirements and regulations in the Russian Federation; therefore this country was not scored.

Conclusions

EU regulations addressing the traceability of a broad range of food and animal products of both domestic and imported origin have established those countries adopting EU legislations as strong leaders in global food traceability.

Even though Japan's beef labeling law for farm-to-fork traceability is applicable only on domestic products now, the Japanese government has adopted new regulations on rice traceability and has various proposed traceability regulations in development for other commodities. This places Japan in a 'fast-track' position in food traceability.

Canada is strengthening its traceability requirements through mandatory livestock identification including a recently announced swine identification and movement tracking program. However, the efforts to create a national traceability system have failed to produce anything beyond limited livestock tracking from birth to death.

The United States trails most other nations in this study on food traceability. While the new FSMA is expected to improve food traceability capabilities, the development of regulations is still in the early stages.

Australia, New Zealand, and Brazil have strong livestock identification systems (specifically for cattle) but need to develop more advanced traceability systems for other domestic and imported products. Requirements for being able to trace and track most foods from farm to fork are still absent.

Although many countries lack specific legislation on food traceability, the global tracing and tracking of imported products is being achieved (often with difficulty) through record keeping (much of it manual), lot identification, labeling laws, and requirements for exporting countries to meet the standards of the domestic industries in those countries.

Reliance on internationally-recognized organizations such as GS1 for uniform product coding and on GFSI schemes for the verification of systems has improved confidence in trading partners across different nations. This trend is expected to continue to mitigate the need for regulations, or complement national regulatory requirements.

Although traceability of livestock and meat products has improved through the harmonization of animal identification systems in many countries, systems allowing for the same level of traceability for other food commodities are still far from being fully implemented.

It would be very beneficial for global markets if countries would move toward the development of an interoperable and uniform global traceability system by following the examples of the EU, and developing uniform requirements for electronic identification, database systems, and interoperability coupled with and supported by globally recognized identification standards and auditing schemes.

Limitations

As noted before, some constraints should be considered along with the results presented in this survey. One main limitation of this study relates to the methodology itself. The State-Pressure-Response methodology has been used on numerous occasions to assess the effectiveness of policy. The methodology is a qualitative method which recognizes that the subjectivity of researchers is intimately involved in scientific research. Subjectivity normally guides the interpretation of data. In qualitative methodology, it is customary to have researchers reflect on the values and objectives they bring to a research project. When looking at the results, the underlying spirit of qualitative research cannot be emphasized enough.

In addition, secondary data were not always available for some of the countries studied. More specifically, the research on non-English-speaking countries (Japan, Russian Federation, and China, for example) was challenging due to linguistic constraints. Some countries are also less transparent than others, which makes the data collection process more intricate. Certain data were therefore processed and analyzed with some level of subjectivity.

Finally, this study includes research published before 2014, which may skew some results. A few agencies and countries publish reports every 2 years or less frequently. In some cases, reports were commissioned and only published once in the past. When looking at these results, it was more challenging to assess historical trends related to food safety which, in turn, affected the ability to objectively rank countries.

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