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The Economics of Implementing Traceability in Beef Supply Chains: Trends in Major Producing and Trading Countries

Traceability is becoming an important instrument to assure food quality, particularly safety, in agri-food chains worldwide. Many countries are developing mandatory or voluntary programs using traceability to assure animal and beef safety. Motivations for their introduction arise from a variety of scientific, social, and economic factors. The systems being developed across countries differ significantly in their details giving rise to trade issues in international markets for live cattle and beef products.

To date there is no full international agreement on the definition of traceability, although it is under intense discussion at the Codex Alimentarius Commission, World Trade Organization (WTO), and International Organization for Standardization (ISO). Generally traceability is defined as the ability to follow the movement of a food through specified stage(s) of processing, production, and distribution but other definitions are also in use. Golan et al. (2003a) characterize traceability systems by their breadth, depth, and precision. They define breadth as the amount of information recorded by the system, depth as how far backward and forward traceability is maintained, and precision as the ability of the system to pinpoint the original source of a problem.

The full economic impacts of traceability systems are likely to be extensive. In addition to their impact on food safety, traceability systems affect animal health and production management decisions (Disney et al., Petit, Vitiello and Thaler). Traceability also affects the structure of supply chains because it requires coordination and allocation of costs and benefits among participants in order to work efficiently (Kola and Latvala). Consumers in different countries show varying levels of familiarity with and willingness to pay for traceability programs. According to Latouche, Rainelli, and Vermersch, French consumers are demanding increasing levels of transparency and traceability and would be willing to pay for it. Dickinson and Bailey suggest that a profitable market for traceability and transparency assurance systems might exist in the United States. Experiments conducted by Hobbs (2002, 2003) in Saskatchewan and Ontario, showed that Canadians would be willing to pay a premium of less than 10% for traceability on a beef sandwich worth C$2.50.

Across countries, a common factor spurring the development of traceability systems has been the presence of bovine spongiform encephalopathy (BSE) in cattle and the suspected relationship between BSE and variant Creutzfeldt-Jakob Disease in humans. The outbreak of BSE in the United Kingdom starting in 1984-1986 caused a sharp decline in consumer confidence in food producers and regulatory agencies. Similar reactions occurred in many other countries where BSE has been found.

Here we discuss the economic implications of traceability in the beef industry, focusing on four areas of impact: human and animal health, liability, trade, and supply chain effects. We then describe the traceability systems being implemented in the seven largest beef producing and trading countries, in terms of the systems' breadth, depth, and precision, and compare the systems' relative advantages and disadvantages.

ECONOMIC IMPLICATIONS OF TRACEABILITY SYSTEMS

Public and private decisions to adopt traceability systems have important economic implications (Hobbs 2003, Golan et al. 2003b). There are different motivations to introduce traceability systems: while private firms are motivated by profits, public authorities are more interested in social welfare. Hence we would expect differences between traceability systems developed by private firms and those mandated or influenced by public authorities. The question of what is the efficient level of traceability and whether it is best attained by mandatory or voluntary rule is an important one (Golan et al. 2004).

Traceability alone does not contribute to higher levels of safety or other quality attributes; it only transfers information along the supply chain. In order for traceability to affect quality it must be associated with some type of quality assurance mechanism that imposes a set of standards and procedures, and specifies data to be recorded, so that quality can be assured (Green and Hy). It is the sharing of information recorded by firms, or by other institutions to which it is passed, which constitutes the bulk of any traceability system.

The economic and technical impact of traceability on the prevention of food safety hazards or in the assurance of other beef attributes will depend on the type of system that is implemented. A deeper system will enable the establishment of links among more agents further up or down a supply chain.

Increased precision means that the origin of an attribute can be more exactly identified (e.g., at the level of a group of animals versus an individual animal). Finally, a broader traceability system enables tracking of a larger variety of attributes throughout supply chains. Clearly, economic and technical decisions on which type of traceability system should be designed involve tradeoffs between system features and their related benefits and costs. Here we discuss four main economic impacts of traceability systems.

Human and Animal Health

The introduction of traceability systems into the beef supply chain has been motivated by human and animal health concerns. The adoption of traceability, along with regular testing of animals, enables authorities to quickly identify the sources of potential animal or human health hazards, limiting the chances of a wider spread of diseases. Animal identification has been used around the world to control a wide range of animal diseases, some of which are simultaneously dangerous to humans. Animal identification is the base for traceability systems in the beef supply chain.

Traceability systems often need to be quite broad to prevent the main human and animal health consequences of food hazards. In most cases, the greater the numbers of potential hazards that are traced the higher are the costs. While some diseases originate in animals and spread through the chain, others appear or become more serious at the processing stage for beef, and still others have consequences only in animals. The depth of the system affects costs and different hazards require different types of systems. For example, prevention of BSE may require information back through animal feeding, while prevention of tuberculosis only requires information about farm practices. The level of precision in the system also affects costs. For example, for some diseases or attributes it is enough to identify the region of origin, but for others it is necessary to know which animal is the source of the hazard or attribute.

Along with the costs of traceability, there are three categories of benefits in terms of human and animal health: a) public health benefits that relate to reduction of foodborne illness; b) private benefits associated with avoidance of bans on sales, mandatory destruction of assets, loss of reputation, and other adverse effects of breakdowns in quality assurance systems; and c) both private and public benefits from faster identification of the emergence and spread of new threats to animal and human health.

A key issue regarding the cost of traceability systems is who will pay for them. The question is important for health issues where there is a potential conflict between the social and the private optimum. Firms do not design traceability systems to maximize public health. However, they may trace attributes that contribute to public health if they believe that by doing so they can increase profits. If a regulator wants a higher level of traceability than firms are willing to provide, policies must be designed to move toward the socially optimum system.

Liability

Gathering and recording information facilitates better identification of the sources of risk. Such identification depends upon the breadth, depth, and precision of the traceability system. When traceability systems are in place, governments may operate more efficient monitoring and inspection programs because instead of directly monitoring agents in the food chain, they may instead check records and their truthfulness. The identification of sources of food hazards or the possible deliberate falsification of the information introduced into databases raises the question of liability.

Liability implies that the source of a given hazard will be held responsible for the consequences of its actions. When it is impossible to identify correctly the source of hazards, it is difficult to hold agents accountable. In such cases there will be a weak effect on behavior due to liability (Buzby, Frenzen, and Rasco). Most opponents of mandatory introduction of traceability mention increased liability as a primary concern.

If the costs of a food safety hazard are entirely imposed on a precisely identified source, the liability risk to the agent in the food chain is increased dramatically. There is also a positive side to liability for the whole industry or governments. It creates an incentive to use safer production and processing methods and to have a pro-active attitude toward identification and prevention of current and future sources of food hazards. This incentive prompted by liability may actually reduce the risks of food safety incidents as firms in an industry strive to avoid losing their reputations and the consumer's trust.

A clear private benefit of traceability systems is the possibility of proving that a given firm was not responsible or does not present a risk when safety issues arise. A firm that is able to prove it does not

have a given animal or public health problem will be less vulnerable to liability than one that cannot. Even if traceability alone does not guarantee safer foods, the information provided and the possibility of fast identification of hazards may diminish the risk perceived by consumers.

Trade Effects

Measures taken to protect against animal and human health hazards often limit international trade. The WTO allows member countries to impose sanitary barriers to trade under the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) and such measures are recognized as legitimate if they are based on sound risk assessment and meet several other criteria. According to Hobbs (2003), mandatory traceability systems may be challenged at the WTO if they violate the rules defined in either the SPS Agreement or the Technical Barriers to Trade (TBT) Agreement. The question of what is a sound risk assessment or scientific justification to impose a safety trade barrier is debatable. The United States and other major exporters of food products constantly challenge EU and Japanese trade restrictions under the SPS Agreement, and to a much lesser extent under the TBT Agreement.

When a major beef importer decides to impose a mandatory traceability system, it will require traceability on imported beef. Assuming such systems are not successfully challenged at the WTO, those countries adopting equivalent traceability systems will have better access to the markets of such importing countries. Producers or countries refusing to adopt equivalent traceability systems will lose markets.

If markets where traceability becomes the standard pay higher prices, then exporting countries would be willing to adopt traceability as long as any higher costs are fully recovered. However, exporting countries with strict traceability could lose markets where traceability is not required because likely higher prices will hurt their competitiveness in those markets. This raises the important issue of harmonization of traceability systems. Harmonization would likely reduce disputes and lead to more transparent transactions but would also fail to accommodate regional differences in needs for such systems.

Supply Chain Impacts

Traceability implies the flow of information about one or more attributes along the supply chain. The control of information is often an instrument of strategic competition, as most firms will only disclose private information if it benefits them. The more broad, precise, and deep the system of traceability is, the easier it will be to spot an individual producer or processor and hold it responsible for a hazard. In such cases the value of anonymity is lost. Hence there is some reluctance by producers and processors to join a traceability system. On the other hand public authorities may desire to have a very transparent supply chain, where information on a set of food safety attributes is widely shared along the chain and with authorities.

Clearly there is a potential conflict between what authorities and firms dealing directly with consumers would like to know about the products and what those producing them are willing to disclose. Since there is a value to information, competition develops not only between firms at the same level of the supply chain but also between firms at different levels or among different supply chains according to the amount of information provided to consumers.

A central economic question in supply chains is who bears the cost and who reaps the benefits of traceability. In most beef supply chains there are differences in market power among the firms and information on food safety attributes is subject to moral hazard and adverse selection. These differences will affect the division of the cost of introducing traceability between chain participants. When governments mandate traceability systems, the question is not only whether consumers want to pay for it through prices or taxes but also to whom that money will be paid.

The design of traceability systems is affected by relationships established along supply chains; the relative power of participants; the breadth, depth, and precision needed; and the value consumers give to the information provided. All these factors also play an important role in the distribution of the benefits and costs of traceability. The general outline of these effects can be seen in comparing traceability systems already in place or being considered in the major producing and trading countries across the world.

TRACEABILITY SYSTEMS IN THE MAJOR BEEF PRODUCING AND TRADING COUNTRIES

We used two main criteria to select countries for comparison: their importance in terms of world production and trade, and their experience with adoption of traceability systems in the beef supply chain. Table 1 compares the countries selected in terms of beef and veal production, exports, and imports. The United States and the European Union are both large producers and traders of beef. Australia, Canada, and, increasingly, Brazil export a large portion of their total production, while Argentina is a smaller exporter. Japan is a very important importer of beef. As discussed below, levels of exports and imports, as well as the size of domestic beef markets, have an important influence on the introduction of traceability systems.

Four patterns of adoption are evident in the major producing and trading countries studied: adoption of mandatory systems in response to consumer concerns (EU and Japan), imposition of mandatory traceability to maintain or enhance export market shares (Australia, Brazil, and Argentina), industry managed mandatory programs for animal identification (Canada), and voluntary systems (United States). Table 2 provides an overall comparison of the systems described.

European Union

The European Union's response to the BSE crisis was premised on the Single European Act of 1986 that allowed the European Commission to propose measures giving consumers a "high level of protection." The January 2000 White Paper on Food Safety contained the road map for the approach to food safety and new European legislation, specifying deadlines for the most important pieces of legislation. This document considered the sharing of information in a transparent, global, integrated, and harmonized way along the food chain and between different member states to be a primary means to regain consumer confidence. Following White Paper proposals, legislation on beef safety was issued in the summer of 2000: Regulation (EC) 1760/2000 of the European Parliament and of the Council on July 17th and Commission Regulation (EC) 1825/2000 on August 25th. Both regulations went into effect on September 1, 2000.

Regulation (EC) 1760/2000 establishes a system to identify, register, and label bovines and beef products. The objectives of this regulation are: 1) to establish an efficient system of identification and registration of bovines at the production stage and 2) to define a common European labeling scheme in the beef sector based on objective criteria at the marketing stage of the food chain.

Under Title I, a mandatory system of animal identification is detailed using two individual ear tags, animal passports,[1] and computerized databases in each member state to establish links between farms and abattoirs where animals are slaughtered. All records must be kept for at least three years, with records in the databases being kept and verified by designated national authorities. Hence, the system allows for a high level of precision in tracing any problem identified in post-mortem inspections.

Under Title II, two labeling schemes are defined to assure traceability from slaughterhouse to retail. Section I, defines the "Compulsory Community Beef Labeling System" and section II the general rules of the "Voluntary Labeling System" allowing producers to extend the level of information provided to consumers. The compulsory system requires that each beef label must include a reference number or code, to ensure a clear link between meat and animal or groups of animals.[2] Labels must also show the approval number and nationality of the slaughterhouse where the animal or animals were slaughtered. If the carcass or group(s) of carcasses is further processed, labels must indicate where those operations occurred. The regulation includes specifics on the labeling of these diverse situations.

All producers or groups of producers who want to extend label information under the "Voluntary Labeling System," must "send a specification for approval to the competent authority of the Member States in which production or sale of beef in question takes place." This specification must include all information placed on the label, measures taken to assure those indications are accurate, a control system to verify the truthfulness of the indication along the food chain, and the name of an independent control

[1] The animal passport is a document issued for each animal within 14 days after birth and is where several records on animal health, movements, and production processes are registered. Jones and Goldsmith, Turan, and Gow elaborate on the legal and economic impacts of animal passports.

[2] The definition of a group of animals to which a label must be linked is given in Article 4 of Reg. (EC) No 1825/2000.

body complying with European Standard EN/45011. Through a procedure described in Article 17, producers in third countries may use a voluntary label system to export beef to the EU.

Commission Regulation 1825/2000, the other regulation on beef safety issued in 2000, laid down detailed rules for the application of Reg. (EC) 1760/2000 in regard to compulsory and voluntary labeling schemes for beef and beef products. This regulation defines traceability as an identification system held by all groups of operators in the same or different parts of the beef supply chain, such that it allows for the establishment of links between meat and an animal or animals. This identification system must at least record information on any arrivals and departures of livestock, carcasses, and/or meat cuts between operators so that correlations are guaranteed. The regulation also defines the required reliability of information contained on labels and in all types of registers. Finally it establishes sanctions for noncompliance, which may include removal of beef from the market.

Overall, the mandatory EU traceability system for beef is in theory quite precise and deep through its mandatory animal identification and compulsory labeling schemes. A possible pitfall of this system occurs in cutting plants where links are established with groups of animals rather than individual ones. The system's breadth is narrow, though a supplementary voluntary scheme may further extend the breadth, depth, and even precision of traceability to include information demanded by consumers or retail chains on production practices, feed, cattle breeds, and other attributes. System precision may be further enhanced if DNA testing to confirm the information in databases is implemented as is being considered.

In its present state of development the EU traceability system generates most of the economic impacts discussed above. The system of animal identification through passports enables authorities and producers to track animal diseases easily and quickly because the passport records every place the animal has been. Since the animal identification system is combined with compulsory labeling, human health hazards are also quickly identified and more easily controlled. The EU is leading the introduction of traceability system worldwide and is a main driver in establishing world standards. Mandatory traceability is likely to have significant impacts on beef supply chains within the EU, although this effect may differ

based on the sophistication of already existing private traceability systems. Recently published papers have started to analyze the economic impacts of the EU traceability system (Buhr, Meuwissen et al.).

Japan

Japan's food safety legislation has been quickly changing since several BSE cases were identified in 2001. The fiscal year 2002 Annual Report on Food, Agriculture, and Rural Areas considers food safety to be a key issue. In July 2002 a law was passed requiring mandatory traceability from feedlots to packing plants. Each animal has to be identified using an ear tag and producers must record data on ID number, breed, sex, and production history. This produces a "family register" for the entire domestic herd. Beginning in 2003 Japanese authorities strengthened the traceability system, requiring its extension from producers through distribution to consumers. The Ministry of Agriculture, Forestry, and Fisheries is formulating more legislation requiring livestock producers to record information on feed (Clemens). Japan already has succeeded in identifying the 4.5 million animals in its dairy and beef herd; full traceability from farm to fork is expected to be in force for all agents in the supply chain by December 2004 (Fitzpatrick 2004)

Japan's traceability system has four levels (Fitzpatrick 2003b): 1) an ear-tag is attached to every living animal and a DNA sample is taken either when it is alive or slaughtered; 2) the DNA sample is enciphered with a 10-digit code corresponding to the animal's ear tag and kept in a database maintained by the Japanese Ministry of Agriculture, Forestry, and Fisheries, with the database accessible by consumers and official authorities; 3) all animal health and feeding information is added to the database under the same enciphered code; and 4) every muscle and offal derived from each animal must retain the same 10 digit enciphered code with which it was originally identified. This code must be kept through every level of the processing and distribution chain.

Pressed by consumers and in anticipation of enforcement of traceability, several Japanese supermarket chains, such as Jusco Supermarkets, are already providing traceability on high-value beef products (Clemens). Consumers can trace the beef they buy to the farm of origin using in-store computers or by accessing the internet at home.

Japan's system will be similar in depth to that of the EU linking beef products from retail stores to farms of origin. While the traceability system is directed at domestically produced cattle, there are indications that it may be extended to imported cattle. Japanese supermarket chains seem to be anticipating this trend (Fitzpatrick 2003a).

The depth of the Japanese system is enhanced relative to the EU system by the potential transparency of the system to consumers. If laws force producers to record information on feed, it will be even deeper. The traceability system will allow consumers to access information on animal production attributes such as date and place of birth, sex, breed, and production history.

The Japanese mandatory system has more breadth than the European system, as it records information on the sex, breed, and details of the production process. Supermarkets have taken the role of assuring consumers on food quality and safety and they are designing broader traceability than required by law, as information on BSE testing, date of slaughter, number of carcass, slaughter number, and name of the producer is also included. Regarding precision, Japan's traceability system is equivalent to the EU one, as each animal is identified and records are kept at the farm level, while movement of the animal and the products it originates are recorded in a database maintained by public officials.

Given the similarities in the systems adopted, the economic impacts of mandatory traceability in Japan are likely to be similar to those experienced in Europe. The introduction of mandatory traceability in Japan is already having a major impact on beef trade. Japan is one of the biggest importers of beef and many of its suppliers are being forced to introduce traceability to have access to Japanese supermarkets. The economic impact is already clear in food chain dynamics as supermarkets give more information to consumers and take the lead in reorganizing the supply chain.

Australia

Australia is the world's largest beef exporter; it is BSE free and is classified as Foot and Mouth Disease free by the OIE.[3] In 1999, 65% of Australian beef and veal production was exported (AFFA). The

[3] The OIE, an intergovernmental organization known as World Organization for Animal Health, was formed by international agreement and currently has 166 country members.

cattle industry and state and federal governments are deeply committed to maintaining the status quo and assuring Australia's position as a quality leader. The Australian beef sector maintains voluntary Quality Assurance Systems for both grass and grain fed animals based on ISO 9002 norms, HACCP, and guidance from stakeholders, independent institutions, and public authorities on animal welfare issues (Meat and Livestock Australia 2002b).

A limited form of traceability was implemented in Australia in the late 1960s as part of brucellosis and tuberculosis eradication campaigns. Under such programs, a Propriety Identification Code (PIC) was assigned to identify each farm; every animal on those farms had to be identified through a tail tag whenever it was moved away from the farm of origin. Using this system, every animal could be traced throughout the slaughter process to the farm of origin (Meat and Livestock Australia 2002b).

The National Livestock Identification System (NLIS) using electronic identification was implemented on a voluntary basis by 1999 in all Australian States. This system became mandatory in the State of Victoria in January 2003. All plants processing for export are required to provide an accurate correlation between carcasses and PIC numbers for trace back purposes (Meat and Livestock Australia 2002b). All other Australian state and territorial governments, along with the industry, have agreed on the goal of introducing the NLIS system on every ranch by July 2004 (Meat and Livestock Australia 2003b). The main motivation for the extension of NLIS is to support and enhance the competitiveness of the Australian cattle export sector and reduce the economic impact of potential animal disease outbreaks.

The NLIS system uses an electronic ear tag or a rumen bolus, which is a device with a radio frequency transmitter placed in the animal's stomach. Each electronic tag includes a unique number that is also printed on ear tags. Each animal is also identified with the PIC number on the tail, linking it to its farm of origin. Each animal movement is recorded in the national database. For example, when the animal leaves the farm, the producer's agent, sales yard, or processor uses a device to read data on the electronic ear tag or rumen bolus and records information in the NLIS database. Hence, the system is precise to both the individual animal and geographical location.

NLIS is administered under the auspices of SAFEMEAT, an industry and government partnership to assure red meat safety and integrity. It is currently managed by Meat and Livestock Australia, which keeps the database. It developed the electronic tag system and software allowing easy access to the database. The system is funded through levies on producers and processors (Beasley).

Traceability can be used to verify the origin and other attributes of beef for both domestic and export markets, though it is more commonly used in the export market. In terms of depth the Australian traceability system, establishes links from farm to the foreign port of import (unless the container number is retained in the importing country) as the PIC number is correlated to the carcass before it leaves the abattoir and the number of the exporting container is recorded in the NLIS database. The National Vendor Declaration provides an auditable trail of the animal's history; it records information on the history of cattle before slaughter. It is legally enforced as vendors face prosecution and severe fines if they are negligent in maintaining this record or give false declarations (Meat and Livestock Australia 2002a). Registration errors are reduced to very low levels by use of electronic chips. Government officials verify the system in slaughterhouses (Meat and Livestock Australia 2002b).

The NLIS traceability system, which is not yet mandatory in all Australian states, is similar in breadth to that of Japan. It includes farm of origin, movements, and information on specific diseases or 'high profile' chemical residue risks. If required by the industry, the system may be expanded to include information on organic production status, welfare, or breed. Electronic animal identification is reportedly more accurate than alternative ear tag devices, making the NLIS system potentially more reliable than those in the EU and Japan.

The system is not really comparable in depth to those of the EU and Japan because it only keeps registries of the carcasses in containers sent to international markets. Therefore there is no registry of all information from farm to fork. However, if the importing country introduced the data into a database it would be possible to associate products to NLIS records.

Trade motivated the Australian traceability system. It was initially an initiative of the beef industry and therefore will presumably be able to capture most of the economic benefits discussed above

in terms of trade effects. Australian state and federal governments are promoting mandatory laws for traceability and have defined a support scheme to build essential infrastructure with a grant of A$5.4 million (Thornton). However, there are still many producers that have not adopted traceability. They could lose both domestic and international markets to competitors, if the current trend toward more traceability persists, but they would have some cost advantages. The impact of traceability on food chains will depend on the relative costs of the identification systems and consumers' attitudes. Supply chains where traceability was introduced have kept their clients in the Japanese market. The impact on animal and human health will be similar to that discussed for the EU and Japan, as the systems are equivalent in terms of breadth and precision.

Brazil

Brazilian beef exports have increased steadily over the last five years (FAOSTAT). According to the Food and Agricultural Policy Research Institute, Brazil had the third greatest market share in beef export markets in the period from 1998 to 2002 and is expected to become the second largest beef exporter by about 2010. Brazil still has to eradicate brucellosis and tuberculosis in its cattle herds but has BSE free status. New legislation introducing programs to control and eliminate animal diseases were issued in 2001 consisting of diagnosis and vaccination of herds. Similar legislation was instituted to control and eradicate Foot and Mouth Disease (FMD).

The Ministry of Agriculture, Livestock, and Food Supply created the Brazilian System of Bovine and Buffalo Identification through Instructive Norm 1 in January 2002. Every bovine and buffalo born or imported must be individually identified, registered, and monitored though a procedure approved by the Ministry of Agriculture. The Brazilian cattle and buffalo herd is expected to be completely identified by the end of 2007. However traceability along the food chain is only required for producers and processors exporting premium beef; it establishes links from farm to slaughter and beef processing facilities. While currently only ear tags are allowed, recent consultations with the cattle industry are pressuring authorities to be more flexible on identification technologies (Lewis).

The system is being implemented over a period of years. All farms and feedlots exporting to the EU were required to have the new identification system in place by June 2002. Those exporting to other markets were required to have such a system ready by December 2003. Only identified cattle are to be exported. Every farm or feedlot located in regions free of Foot and Mouth Disease must be identified by December 2005 and the remaining by December 2007, when identification of all cattle herds will be mandatory.

The Secretary for Animal and Plant Safety maintains an electronic database to control all identified animals. All registries on the database must be updated whenever animals are moved to other farms, to slaughter, or to processing plants. Private or public certification bodies, approved by the Ministry of Agriculture, visit farms, abattoirs, and processing facilities to verify the accuracy of registries. The system is precise to the level of the farm of origin or animal.

Information on farm of origin, individual ID, month of birth or entry on farm, sex and aptitude (dairy or beef), system of production, movements, and sanitary data are recorded in the system and verified by certification entities. Every import of cattle must be reported to the official database and all information relating to those animals must be recorded. Whenever an animal dies due to a natural cause, accident, or on farm consumption, this information must be given to the authorities. Abattoirs must notify which animals were slaughtered and are responsible for transmitting all documents to the Federal Inspection Services of the Ministry of Agriculture. These registries make the system quite broad when compared with other major exporting countries. Some Brazilian states are proposing their own systems with even more breadth, e.g., for organic livestock in Parana (Lewis).

The Brazilian system has less depth than those of the EU, Japan, and Australia since traceability extends only between the farm of origin and the abattoir. Overall, the Brazilian system is comparable to those of the EU, Japan, and Australia in terms of breadth. It is as precise as the EU, Japanese, and Australian systems as it allows for individual animal identification. It may be less accurate than the Australian system because it does not rely on electronic identification.

There are two main motivations for the introduction of traceability systems in Brazil: control of animal diseases such as FMD and tuberculosis and maintenance of premium beef export markets. Brazilian authorities and producers are willing to increase their food safety related costs as they believe the price they will get in premium markets largely compensates them. FMD and tuberculosis generate costs, not only because it becomes harder to export beef but also because production costs increase. Imposing mandatory identification will enable authorities and producers to more easily control or even eliminate such diseases, with evident benefits.

Argentina

Argentina has always been a net beef exporter, although in recent years economic recession and a Foot and Mouth Disease (FMD) outbreak have had a major impact on export volume. The European Union is an important buyer of Argentinean beef, especially of high quality fresh beef cuts imported under the Hilton quota. Argentina is considered to be BSE free.

Animal diseases such as brucellosis, tuberculosis, and Foot and Mouth Disease have yet to be totally eradicated in Argentina (SENASA 2003). Due to the persistence of these diseases in the Northwest Provinces, Regulation 345/98, issued on April 4, 1998, modified the requirements for beef and other ruminants exported to the EU. Every animal destined for export is required to carry a document, signed by an official veterinary, assuring that the animal is free of diseases and did not originate in a foreign country or province where disease persists. Resolution 625/2002, issued on July 24, 2002, requires that all animals exported to the EU must have remained in Argentina for at least 3 months prior to slaughter and can only originate from a limited number of countries. This resolution also requires that all facilities producing cattle destined for export must have an approved sanitary status and all animals within each facility must have an individual Sanitary Certificate assuring that it is free of animal diseases.

In January 2003, Resolutions 001/2003 and 002/2003 were published to assure traceability to the EU by creating procedures to register abattoirs, processing facilities, and feedlots authorized to export beef. The central traceability regulation followed in February in Resolution 15/2003 creating the Export Cattle Identification System. This system requires mandatory identification of every animal originating on

farms and feedlots that is exported. All animals have to bear a tag on the left ear with an individual and non-repeatable code, as well as an identification of the farm where it was born. The animal must also carry the National Sanitary Register of Livestock Producers brand on its back. Every facility authorized to export must register the existence and all movements of animals in a book of registries approved by the regional branch of the Argentinean National Service of Agro-Food Safety and Quality. The Resolutions on the traceability system took effect in May 2003.

Argentina has established a limited mandatory system of traceability directed at export markets. The depth of the Argentinean system is from the farm to the export port where carcasses or beef cuts leave the country. The system is deeper than that of Brazil as it establishes links beyond abattoirs but is not as deep as those in Japan, the EU, or Australia because it does not reach retailers or import ports. The characteristics recorded are not as broad as those in the Brazilian system and are also more limited than in Australia, Japan, or the EU. The system is able to trace back to individual animals and their respective farms of origin, but it lacks precision and accuracy as it relies quite extensively on information provided by operators and does not employ an integrated database. Another issue with Argentina's system is that it is of limited scope as it only applies to export cattle.

Argentina is an example of how traceability is limited by economic conditions. The economic crisis of 2002 limited the capacity for introducing systems equivalent to those in Australia or Brazil, which are direct competitors of Argentina in international beef markets. Legislation was only introduced in early 2003 and it seems to have been a reaction to pressures from the EU. Hence in the Argentinean case traceability is mainly motivated by trade, as only beef destined for export markets must be identified. Given that FMD and other animal diseases are not yet controlled, we would expect to see an economic motivation to extend traceability to the rest of cattle herd, as is happening in Brazil. A comparison of economic motivations for adoption of traceability in the two countries would make an interesting case study.

Canada

The current Canadian approach to beef safety is at a midpoint between the EU and the US systems. Full traceability from farm to fork is not mandatory but cattle must be identified when they are moved from the farm where they were born to another farm, slaughterhouse, or export. Historically, mandatory animal identification was used extensively to assist in eradication of animal diseases such as brucellosis and tuberculosis but the system was relaxed after 1985 when those diseases were eradicated. In the late 1990s only about 10% of the total cattle herd was identified (CFIA 2000a). However, the industry and provincial and federal authorities were prompted to rethink their attitudes towards animal identification, by the appearance of the first BSE cases in the UK, the outbreak associated with *E. coli* in the US, and the fact that Canada is highly dependent on export markets.

In December 2000, Part XV of the Health of Animals Regulations of 1991 was amended to include animal identification, to take force in July 2001. The industry led Canadian Cattle Identification Agency (CCIA), established in 1998, was mandated to administer the Canadian Identification System (CFIA 2000a). Section 175 of the Amendment requires that "every person who owns an animal or has the possession, care, or control of it shall ensure that it is identified by an approved tag applied to it before it is moved from its farm of origin." Section 186 specifies procedures for abattoirs. The operator of the facility is allowed to remove the tags from animals to be slaughtered but must notify authorities of the deaths of the animal and their tag numbers within 30 days. Identification is also required for imported cattle, which must be given a Canadian approved tag as they enter the country. In addition, Section 189 requires that all existing information on imported animals must be referred to the administrator to allow trace back to origin. Cattle exported from Canada must also bear an approved tag; importing authorities may remove the tag as the animal enters the new country.

The Canadian Food Inspection Agency (CFIA) enforces this identification system. When tags are missing cattle producers pay a fine in terms of the percent of missing tags; if they willfully clip tags out, producers have to pay a C$1000 fine. Overall the compliance is estimated to be at a 95% level (Lawrence et al.).

The Canadian Animal Identification System is not as complex as those in the EU or Japan. Only animals that leave the original farm must be identified and only the system's administrators keep records. The system is not as deep as those in the EU and Japan as it does not extend to retail. However it does allow tracing back from export ports to original farms. For the domestic market only linkage between abattoirs and farms of origin is mandatory. The database maintained by CCIA was instrumental in the first Canadian case of BSE in May 2003 for identification of the offspring of the infected cow. Experts argue that the system could be improved and officials say that if more information was recorded 1000 of the 2,700 animals slaughtered in response to the BSE case could have been spared (Binkley).

In terms of economic impact, the Canadian Animal Identification System proved useful but by no means totally effective in preventing losses when a major crisis arose (Caswell and Sparling). Between May and June 2002, at the peak of the BSE crisis, cattle prices dropped by over 50% and exports were totally banned (Lawrence et al.). This case helps explain why countries where exports are important (such as Canada, Australia, Brazil, and Argentina) are determined to introduce traceability and further quality assurance, as this is becoming a condition for access to premium export markets. Much as in the EU and Australia, public authorities have contributed significantly to the introduction of traceability in Canada but the producers still have to bear the cost of purchasing the tags and providing information to CCIA.

Since traceability is not extended to retail in Canada, the impact on the supply chain is smaller than that already visible in the EU and Japan. Since the system is mandatory, there are not the opportunities for beef supply chain competition for domestic markets that exist in the cases of Australia and Brazil. However there is international competition with supply chains of these former countries for high quality beef markets. Finally, the design of the Canadian system enables authorities to capture all the animal health benefits described above. However it falls below the systems of the EU or Japan in terms of potential human health benefits as it does not record information beyond abattoirs.

United States

Before December 23, 2003, when the first case of BSE was confirmed in Washington State, federal authorities did not have a mandatory policy for using traceability to prevent or diminish the impact

of animal health or food safety hazards. As a result, the source of the BSE case was only determined some time later.

Golan et al (2004) report the existence of several beef traceability systems in the US. Though state authorities have promoted some, they have been mainly private and market driven. Traceability also has been mentioned in connection with requirements for Country of Origin Labeling (COOL) for beef, other meats, fruits, and vegetables that are a part of the Farm Security and Rural Investment Act of 2002. USDA has proposed guidelines but final regulations have not been issued and recently Congress approved a 2-year moratorium on this legislation. Furthermore, while the proposed COOL system would track country of origin, enabling retailers to label it (e.g., for a beef product whether the animal was born and raised in the US), it would not provide traceability that could link a particular animal or beef product through the supply chain. In fact, Section 282, (f), (1) states that mandatory identification systems are prohibited.

Earlier events and the Canadian and US BSE cases have changed the perspective on traceability of the government and industry in the United States. A team composed of experts representing the industry and state and federal authorities are working on a proposal for the creation of the United States Animal Identification Plan (USAIP). This effort was initially led by the National Institute for Animal Agriculture and is now led by the National Identification Development Team. It is scheduled to work in phases, with premise identification targeted for 2004, individual identification for commerce by 2005-2006, and enhanced technology for tracking by 2005-2006. It is not clear whether the system will be voluntary or mandatory (Clapp 2003a and 2004).

There are currently no mandatory beef traceability systems in the United States. However, private, voluntary traceability systems are widespread in industry (Golan et al. 2003a). In August 2003, USDA launched the voluntary Beef Export Verification (BEV) program that assures Asian buyers that products shipped overseas come from animals slaughtered in the United States. Under this program the Agricultural Marketing Service of USDA conducts process verification audits for operators eligible to export to Japan under the program (Clapp 2003b). However, this market has been closed since the

confirmation of the first BSE case in December 2003. Overall interest in traceability systems is growing throughout the supply chain, particularly for the export market and for serving specific consumer segments within the United States.

In the US both public and private authorities are now promoting the introduction of traceability systems. They are responding to concerns of international or domestic business partners; hence we would expect supply chain dynamics and international demand to be the drivers of traceability in the US. Concerns with liability have been one of the main barriers to traceability; many beef producers are concerned with the consequences for their businesses if they could be positively associated with an animal health or food safety hazard. There is less appreciation of the opportunities for assuring customers of quality through traceability. It will be interesting to see how the perceptions of producers of the riskiness of traceability change over time. The recent BSE case highlighted the disadvantages in terms of slow reaction times of not having any type of national animal identification system. Further analysis will be needed to compare the benefits and costs of a voluntary scheme versus adopting a system closer to that of Canada or Australia where there is a mandatory identification of animals but many traceability details are left to the industry.

Overall Comparison

Table 2 summarizes our overview of traceability in beef supply chains in major producing and trading countries. There are clearly different approaches to date in establishing these systems. A central distinction is between countries that impose mandatory systems, a combination of mandatory and voluntary systems, and voluntary systems. The EU and Japan have mandatory traceability; all beef produced domestically must be traceable backward and forward from retail to farm of origin. Australia and Brazil have plans for general mandatory traceability but traceability is currently mandatory only for exported beef, particularly for export to the EU and Japanese markets. Canada has a mandatory animal identification scheme for all animals moving away from the farm of origin. This system establishes links between farms of origin and abattoirs or export ports, when animals or products are exported. Argentina has a mandatory traceability system only for beef being exported; animals and meat sold domestically

does not have to be identified, unless it is produced in regions where animal diseases still persist. Finally, to date traceability is voluntary in the United States.

There are also differences between systems in terms of their depth, breadth, and precision. The mandatory systems in the EU and Japan are the deepest. They link information on the origin of the animal to the retail store through label information on the final package. The Australian system does not link abattoirs to retail stores but when beef is exported the containers and their contents are registered in the system, allowing for importing agents to use such information. Brazil, Japan, Australia, and the EU have the broadest systems, although in most cases systems can be implemented on a broader scale on a voluntary basis. Canada and, especially, Argentina have simpler traceability systems in terms of breadth. Japan, the EU, Australia, and Brazil have developed the most precise systems as individual animals and their farms of origin can be linked with beef products. All these systems rely on verification by public or private auditors. In addition, Japan is using DNA samples to confirm the accuracy of databases. The Australian beef traceability system is based on electronic tagging, which is reported to be very accurate in gathering and recording information. Canada and Argentina depend on the information given by farmers and processors, with no public or private verification.

CONCLUSION

Traceability is already changing the international beef market. It is becoming clear that there are at least two types of beef markets according to the ability to trace. The question is whether in the future all traded beef will be traced according to its different attributes or there will still be a place for beef that is not fully traceable. Most beef exporting countries are adopting some kind of traceability system in response to mandatory systems introduced in such important importing countries for high quality beef cuts as Japan and the European Union. The exporters' main motivation is to maintain or increase their positions in international markets for beef.

Traceability systems are a way to assure that credible information on credence attributes, such as food safety, flows across agri-food marketing chains from farm to fork. These systems are developing at a different rate across trading partners. In many countries, traceability is being instituted first in the beef

supply chain. The European Union and Japan are leading the trend toward adoption of mandatory traceability to prevent or diminish risks to animal and human health. They have the broadest, deepest, and most precise beef traceability systems. Australia and Brazil, where the beef export market is important, are closely following this trend. Argentina and Canada have recently adopted mandatory traceability systems but they are less extensive than the EU or Japanese systems. The United States has not adopted mandatory traceability systems, although several voluntary systems are operating and new systems are being developed.

The economic implications of mandatory and voluntary traceability systems are just beginning to be played out. They will be especially prominent in the areas of animal and human health, international trade, and supply chain dynamics. The countries that have already adopted traceability systems have positioned themselves to gain the economic benefits of such systems, either domestically or in export markets. The extent to which these benefits justify the costs of such systems and how benefits and costs will be distributed remains to be fully analyzed. Overall, it is clear that traceability will become an increasingly integral feature of markets for food products.

REFERENCES

AFFA (Department of Agriculture, Fisheries and Forestry Australia). "Meat Type by State Report: Exports as a Percentage of Production (Tones)–Period Range July 1998 to June 1999." August 1999: 1.

Animal and Plant Health Inspection Service. "Why the Need for Livestock Inspection." http://www.aphis.usda.gov/vs/nahps/animal_id/.

Beasley, R. "National Livestock Identification Scheme: A New Era in the Identification, Tracing and Management of Cattle." Proceedings of IT Advances in the Livestock Industry Paddock to Plate Conference. Armidale, NSW, Australia, October 2002.

Binkley, A. "Canadian BSE Incident Highlights Trace Back Importance." *Food Traceability Report* 3 (9 2003): 6-7.

Buhr, B. L. "Traceability and Information Technology in the Meat Supply Chain: Implications for Firm Organization and Market Structure." *Journal of Food Distribution Research* 34 (3 2003): 13-26.

Buzby, Jean C., Paul D. Frenzen, and Barbara Rasco. 2001. *Product Liability and Microbial Foodborne Illness*. Agricultural Economic Report Number 799, U.S. Department of Agriculture, Economic Research Service, Washington, DC. http://www.ers.usda.gov/publications/aer799/

Canadian Food Inspection Agency (CFIA). "Regulatory Impact Analysis Statement." 2000a. http://www.inspection.gc.ca/english/reg/appro/2000/99013ria_e.html.

------. "Regulations Amending the Health of Animals Regulations. 1." http://www.inspection.gc.ca/english/reg/appro/2000/99013_e.shtml.

Caswell, Julie A. and David Sparling. "Risk Management in the Integrated NAFTA Market**:** Lessons From The Case of BSE." Commissioned paper presented at the First Annual *North American Agri-food Market Integration Workshop*, Cancun, Mexico, May 2004.

Clapp, S. "US Animal Identification Scheme Expected in October." *Food Chemical News* 45 (28 2003a):1, 27-28.

------. “USDA Launches Beef Export Verification Program.” *Food Traceability Report* 3 (9 2003b):7.

Clemens, R. “Meat Traceability and Consumer Assurance in Japan.” MATRIC Briefing Paper 03-MBP 5. Iowa State University. September 2003.

Commission of the European Communities. White Paper on Food Safety. COM(1999) 719 final, Brussels, January 2000.

Dickinson, D. L. and D. Bailey. “Meat Traceability: Are U.S. Consumers Willing to Pay for It?” *J. Agr. Res. Econ.* 27(2 2002):348-364.

Disney, W.T., J. W. Green, K.W. Forsythe, J.F. Wiemers, and S. Weber. “Benefit-Cost Analysis of Animal Identification for Disease Prevention and Control.” *Rev. Sci. et Techique de l’Office Internacional des Epizooties* 20(2 2001):385-405.

European Commission. “Commission Regulation (EC) No 1825/2000, Laying Down Detailed Rules for the Application of Regulation (EC) No 1760/2000 of the European Parliament and of the Council as Regards the Labeling of Beef and Beef Products.” Official Journal of the European Communities, L 216 (2000): 8-12.

European Parliament and Council. “Regulation (EC) No 1760/2000, Establishing a System for the Identification and Registration of Bovine Animals and Regarding the Labeling of Beef and Beef Products and Repealing Council Regulation (EC) No 820/97.” Official Journal of the European Communities, L 204 (2000): 1-10.

FAOSTAT Database. “Beef and Veal Production and Trade Statistics.” 2003. http://apps1.fao.org.

Fitzpatrick, M. “Japan Seeks Total Traceability in its Food System. *Food Traceability Report* 3 (2 2003a): 1 &19.

------. “Japanese Food Safety Heralds Traceability Era.” *Food Traceability Report* 3(6 2003b): 1 &18.

-----. “Japanese Retailers Seek to Ensure Beef Traceability”. *Food Traceability Report* 4(1 2004): 1 &11.

Food and Agricultural Policy Research Institute. “FAPRI 2003 U.S. and World Agricultural Outlook.” Staff Report 1-03 (2003):342-347.

Goldsmith, P, N. Turan, and H. Gow. "Food Safety in the Meat Industry: A Regulatory Quagmire." *International Food and Agribusiness Management Review* 6 (1 2003).

Golan, E, B. Krissoff, F. Kuchler, K. Nelson, G. Price, and L. Calvin. "Traceability in the US Food Supply: Dead End or Superhighway." *Choices (*2 2003a):17-20.

------. "Traceability for Food Safety and Quality Assurance: Mandatory Systems Often Miss the Mark." *Current Agr., Food, & Resource Issues* (4 2003b):27-35.

------. "Traceability in the U.S. Food Supply: Economic Theory and Industry Studies." Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 830. March 2004.

Green, Raul and Michel Hy. "Traçabilité Alimentaire, Enjeux et Perpectives". INRA—Loria, Ivry Sur Seine. Paris. France. January 2002.

Hobbs, J.E. "Consumer Demand for Traceability." Paper presented at the International Agricultural Trade Research Consortium Annual Meeting, December 2002.

------. "Traceability in Meat Supply Chains." *Current Agr., Food, & Resource Issues* (4 2003):36-49.

Japan Agrinfo Newsletter. "MAFF to Harness JAS as Means of Ensuring Beef Traceability." 20 (11 2003). http://www.jiac.or.jp/agrinfo/0307.html.

Jones, E. "Entity Preservation and Passport Agriculture: EU vs. USA." *Drake Journal of Agricultural Law* (7 2002):381-406.

Kola, J. and T. Latvala. "Demand for Credence Characteristics in Beef." Selected paper presented at the AAEA-WAEA Annual Meeting, July 2002.

Latouche, K., P. Rainelli, and D. Vermersch. "Food Safety Issues and the BSE Scare: Some Lessons from the French Case." *Food Policy* 3 (5 1998):347-356.

Lawrence, J. D., D. Strohbehn, D. Loy, and J. Clause. "Lessons Learned from the Canadian Cattle Industry: National Animal Identification and the Mad Cow." MATRIC Briefing Paper 03-MBP 7. Iowa State University. October 2003.

Lewis, S. "Brazil Considers Livestock Traceability Alternatives." *Food Traceability Report* 3 (9 2003):7-8.

Meat and Livestock Australia. "National Vendor Declaration for Cattle—9th Edition. On Farm Tips and Tools." Quality Assurance QA07. July 2002a. http://www.mla.com.au/uploads/templates/publicationspdf/1740363752.pdf

------. "Australian Beef: Safe, Healthy and Delicious." 2002b.

------. "Japan Information Centre. Current Issues: BSE, Labelling, Traceability, and Safeguards." 2003a. http://mla.com.au/content.cfm?sid=1213.

------. "About the NLIS." "How to Participate–Producers and Feedlots." "Cattle Traceability." 2003b. http://www.mla.com.au/content.cfm?.

Meuwissen, M. P. M, A. G. J. Velthuis, H. Hogeveen, and R. B.M. Huirne. "Traceability and Certification in Meat Supply Chains." Journal of Agribusiness 21 (2 2003):167-181.

Ministério da Agricultura, Pecuária e Abastecimento. "Instrução Normativa nº 1 de 10 de Janeiro 2002." Diário Oficial da União (D.O.U), seção 1, 01/10/2002: 6.

Office of Legislative Drafting. "Australian Meat and Livestock Industry Act 1997, Act No. 206 of 1997," compilation prepared on 16 October 2001.

Office Internacional des Epizooties. "Répartition Géografique des Pays ayant declaré au moins un cas confirmé de ESB entre 1998 et le Octobre 2002." http://www.oie.int/Cartes/BSE/f_Monde_BSE.htm

Petit, R.G. "Traceability in the Food Animal Industry and Supermarket Chains." *Rev. Sci. et Techique de l'Office Internacional des Epizooties* 20 (2 2001):584-597.

Servicio Nacional de Sanidad y Calidad Agroalimentaria (SENASA). "Planes de Control y Erradicacion de las Enfermedades que Atacan a los Animales." http://www.senasa.gov.ar/

------. "Resolucion 625/2002 of July 24th 2002." http://infoleg.mecon.gov.ar/normas/76317.htm

------. “Resolucion 001/2003 of January 2nd 2003.” http://senasa.gov.ar/legislacion/res-2003/Animal/20020102-001.htm

------. “Resolucion 002/2003 of January 2nd 2003.” http://senasa.gov.ar/legislacion/res-2003/Animal/20020102-002.htm

------. “Resolucion 15/2003 of February 5th 2003.” http://infoleg.mecon.gov.ar/normas/82236.htm

State of Victoria, Department of Natural Resources and Environment. “Your Guide to Victoria’s Cattle Identification Legislation, Answers to Commonly Asked Question.” January 2002.

Thornton, M. “Australia National Livestock Identification Scheme Still Under Fire.” *Food Traceability Report* 3 (8 2003):1&8.

United States Animal Identification Plan. 2004. http://www.usaip.info

United States Congress. Public Law 107-171: Farm Security and Rural Investment Act of 2002, Subtitle D-Country of Origin Labeling (COOL Act), SEC. 282, (f), (1). May 2002.

Vitiello, D. J. and A. M Thaler. “Animal Identification: Links to Food Safety.” *Revue Scientifique et Techique de l’Office Internacional des Epizooties* 20 (2 2001):598-604.

Wilson, L. “Japan Passes Mandatory Traceability Legislation.” *NLIS News* (10 2003):1.

Table 1. Beef and veal production and trade

Country/year		1999	2000	2001
European Union	Production (MT)[a]	7,679,182	7,418,295	7,343,842
	Import (MT)	198,707	201,865	201,865
	Export (MT)	692,338	440,143	440,143
Japan	Production (MT)	540,377	530,438	458,034
	Import (MT)	677,373	719,354	674,938
	Export (MT)	120	165	63
Australia	Production (MT)	2,010,530	1,987,902	2,080,000
	Import (MT)	1,314	1,048	924
	Export (MT)	913,824	929,797	970,642
Brazil	Production (MT)	6,413,300	6,540,000	6,671,000
	Import (MT)	37,485	50,895	31,041
	Export (MT)	150,740	188,656	368,287
Argentina	Production (MT)	2,719,784	2,718,000	2,452,000
	Import (MT)	11,934	10,271	10,516
	Export (MT)	159,956	159,837	42,822
Canada	Production (MT)	1,263,816	1,264,138	1,249,956
	Import (MT)	177,783	184,261	212,480
	Export (MT)	370,438	394,168	434,793
United States	Production (MT)	12,123,000	12,298,000	11,983,000
	Import (MT)	882,047	953,142	987,463
	Export (MT)	766,212	899,834	780,515

[a]Metric tons.

Source: FAOSTAT.

Table 2. Comparison of country-level beef traceability systems in terms of depth, breadth, and precision[a]

Country	System Type[b]	Depth[c]						Breadth[c]		Precision[c]		Integrity Verification[c]	
		Feed producers to retail	Retail to farm	Farm to abattoir	Abattoir to retail	Abattoir to export ports	Abattoir to import ports	Safety and origin	Safety, origin, animal welfare, feed and others	Individual animals to their place of birth	Groups of animals to place of birth	DNA	Other
EU	B	P	X	X	X			X	P	X	X	P	X
Japan	B	P	X	X	X			X		X		X	
Australia	ME			X			X	X	P	X		P	
Brazil	ME			X					X		X		X
Argentina	ME			X		X		X			X		
Canada	M			X		X		X			X		
US	V		P	P	P			P		P			

[a]Golan et al. (2003a) define breadth as the amount of information recorded by the system, depth as how far backward and forward traceability is maintained, and precision as the ability of the system to pinpoint the original source of a problem.

[b]M=Mandatory, V=Voluntary , B= Both Mandatory and Voluntary, ME=Mandatory for Export.

[c]X=characteristic of present system, P=potential characteristic of system.