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# International Trade and Food Safety

## Economic Theory and Case Studies

Jean C. Buzby, editor

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# International Trade and Food Safety: Economic Theory and Case Studies

**Jean C. Buzby, editor**

## Abstract

Food safety regulations and the perception of risk are different among countries. This can lead to persistent trade frictions and even reduce food trade. These differences may also lead to increased dialogue between countries, with improved food safety systems the result. Although little disruption to trade has occurred for food safety reasons (considering the total volume of food trade), trade issues or crises related to food safety are wide ranging. These issues and crises challenge policymakers and industries to both protect domestic food supplies and nurture international markets. Meanwhile, consumers in developed countries are demanding safer food. Risk reduction measures and quality certification programs can not only pre-empt food safety crises, but can better position exporters in emerging overseas markets. However, coherency between trade and food safety goals requires public intervention and investment and/or private costs.

**Keywords:** Food safety, international trade, regulation, *Salmonella*, BSE, produce, seafood, trade liberalization.

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# Summary

This report presents ERS research on the interaction between food safety and international trade. Food safety challenges are mounting and crises like "mad cow disease" are becoming more pronounced. Growth in world food trade means that U.S. consumers are more dependent on the food safety measures used in other countries and that there are greater opportunities for U.S. food exports.

This research was performed by examining the conceptual relationships between food safety and international trade and by examining the meat and poultry, produce, food/animal feed crop, and seafood sectors for trends in trade, food safety regulation, and the resolution of incidents and disputes related to both.

*Food safety regulations and standards evolve differently around the world as countries respond to food safety crises and prepare for perceived exposure to emerging food safety risks.* Regulations and standards worldwide are shaped by: (1) countries' experiences with food safety, (2) inherent food safety risk levels in each country's food supply (e.g., livestock host factors), (3) countries' and industries' ability and willingness to allocate resources to control these risks, and (4) differences in consumers' food safety perceptions and, hence, preferences for targeting risk reduction efforts. For example, countries' perceptions about *Salmonella* risks in poultry vary tremendously, as do their commitments and methods of control. As a result, countries' trade restrictions for *Salmonella* vary by type, extent, and duration.

*These differences in regulations and standards among countries can lead to international trade conflicts or disputes and can ultimately affect global patterns of food demand and reduce trade.* In particular, food safety-related disputes among trading partners may arise from:

- New or more stringent standards and rapidly changing food safety regulations,
- The difficulty of separating the roles of food safety and non-science issues (e.g., consumer preferences) in regulatory decisionmaking,
- Difficulties in determining whether an equivalent safety outcome has been achieved when process standards are used,
- Strong differences in consumer risk perceptions and preferences,
- Newly identified or unfamiliar hazards, and
- Increased trade volumes from new or less proven sources.

Therefore, the causes of food safety-related trade disputes are varied, complex, and tenacious. For example, the 1989 European Union ban on animal growth hormones originated from concerns there about the effects of hormones used in beef production on human health. The scientific basis of the ban was later successfully challenged by the U.S. and Canada, but the European Union (EU) has still not lifted its ban. This is the only food safety dispute that has advanced to a World Trade Organization dispute panel.

Although differences in standards and regulations may lead to conflicts and disputes, they may also spur fruitful dialogue between countries, causing some countries to alter and improve their food safety systems. For example, regulatory agencies worldwide are increasingly adopting the Hazard Analysis and Critical

Control Point (HACCP) system as a foundation for new regulations to control microbial pathogens in food.

*There has been relatively little disruption to food trade for safety reasons* when considering the magnitude of global food and agricultural trade ($436 billion in 2001), notable changes over the past decade in food consumption, production, and trade (for example, the increased consumption of food away from home, greater livestock concentration, and increased volume of food trade); the vast number and variety of food categories and products traded; the roughly 200 countries participating in food trade; and challenges to food safety that include pathogens, pesticide and drug residues, food additives, environmental toxins, persistent organic pollutants, unconventional agents such as those associated with "mad cow disease," and zoonotic diseases. However, the globalization of the food supply could introduce new food safety risks, revive previously controlled risks, and spread contaminated food wider. For the United States, there is no evidence as to whether food safety risks are increasing, remaining stable, or decreasing with trade.

*Trade frictions related to food safety can be persistent, and any coherency between trade and food safety goals will likely require private costs and/or public intervention and investment.* Global food trade will continue to increase due to improvements in transportation, infrastructure, and marketing networks, and to global increases in per capita income levels and populations. Consumers in developed countries are demanding certain attributes in food, like safety. Therefore, improving food safety and expanding international trade are compatible—even mutually reinforcing—goals. Governments and the private sector must react quickly to new food safety crises in order to minimize human illness and financial losses. But governments also invest in food safety to protect human health and expand food markets indefinitely. The private sector will be similarly pre-emptive where market incentives are strong.

# Abbreviations and Acronyms

| | |
|---|---|
| BSE | Bovine spongiform encephalopathy |
| CODEX | Codex Alimentarius Commission |
| COI | Cost of illness |
| ERS | Economic Research Service |
| EC | European Commission |
| EU | European Union |
| FAS | Foreign Agricultural Service |
| FDA | Food and Drug Administration |
| FSIS | Food Safety and Inspection Service |
| GATT | General Agreement on Tariffs and Trade |
| HACCP | Hazard analysis and critical control point |
| NMFS | National Marine Fisheries Service |
| SPS | Sanitary and phytosanitary |
| USDA | U.S. Department of Agriculture |
| WTO | World Trade Organization |

*Chapter 1*

# Introduction and Overview

Jean C. Buzby and Laurian Unnevehr[1]

## Background

Increased international food trade means that countries share the responsibility for food safety, which pertains all along the food supply chain from producers to consumers. With increased international food trade, this supply chain transcends international borders. Consumers benefit from worldwide trade through lower prices, year-round supplies, and a greater quality and variety of food. However, globalization of the food supply could introduce new food safety risks, revive previously controlled risks, and spread contaminated food wider. For food producers, food safety issues can raise production costs, influence reputation, and close off international markets.

Trade in international markets may introduce new costs for addressing and managing food safety hazards. Most internationally traded food poses no human health risks, with food safety incidents rare considering the total volume of trade. Trade disputes over food safety, however, can be persistent, and may require public intervention/investment and private costs to overcome. This report highlights how food safety disputes and challenges arise and are resolved.

Although food safety standards are frequently viewed as technical barriers to trade, improvements in food safety and expanded international trade are likely compatible and even mutually reinforcing. Domestic and international firms share and respond to the same incentives to provide safer food. Reputation and sales can be enhanced for those exporting firms and industries making noticeably safer products, whereas firms implicated in a food safety crisis may suffer a wide range of business losses. From our research here, we believe that, over time, food safety should continue to improve worldwide with the spread of private and public food safety control efforts, increased scientific understanding about food safety, and improved dialogue between countries.

Food safety risks are defined here as they pertain to human health, covering well-established and perceived impacts from agents and sources including: (1) microbial pathogens (i.e., illness-causing bacteria, viruses, parasites, fungi, and their toxins); (2) residues from pesticides, food additives, livestock drugs, and growth hormones; (3) environmental toxins such as heavy metals (e.g., lead and mercury); (4) persistent organic pollutants (e.g., dioxin); (5) unconventional agents such as prions associated with bovine spongiform encephalopathy (BSE) or "mad cow disease" in cattle; (6) zoonotic diseases that can be transmitted through food from animals to humans (e.g., tuberculosis); and (7) foods produced or processed with practices perceived to involve risks, such as irradiation. Scientists generally agree that food safety risks are low relative to many human health risks such as cancer and heart disease. Among food safety hazards, human health risks are highest from foodborne pathogens such as *Campylobacter* and *Salmonella*, each of which causes well over a million illnesses annually in the United States (Mead et al., 1999). These are also common pathogens worldwide.

Food safety and trade issues related to it are becoming more pronounced. There has been an increased scientific awareness of the public health risks from unsafe food, including both acute and long-term health consequences (Lindsay, 1997). Many foodborne pathogens and diseases, such as new pathogenic strains of *E. coli*, are emerging as technological improvements enable their detection (Käferstein et al., 1997). Also troubling is accumulating evidence that some pathogens are becoming resistant to certain antibiotics (GAO, 1999; Tauxe, 1997). Public health authorities are growing more engaged with food safety as improvements in information and reporting systems accompany greater concern about food safety in general (Käferstein et al., 1997).

The traditional foodborne outbreak scenario is changing (Tauxe, 1997). In the past, outbreaks were mostly

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acute and highly local and resulted from a high level of contamination. Now, we see relatively more outbreaks from low level contamination of widely distributed commercial food products affecting many counties, States, and nations. This development has been attributed to changes in food production and distribution and to the growth of international trade.

The U.S. food system is changing at all levels—consumption, production, and trade. These changes alter the nature and incidence of food safety risks. In the past few decades, consumption of poultry, fish, fruits, and vegetables has increased (Regmi, 2001), as has consumption of prepared foods and foods consumed away from home (Lin et al., 1999). Meanwhile, the demand for better food safety has tended to increase with growing consumer affluence and awareness of food safety issues (Hooker and Caswell, 1999). Food production has changed notably, leading to a different set of food safety risks for the food industry to manage. For example, U.S. aquaculture production increased by over 50 percent between 1990 and 2000 (NMFS, 2002) and the aquaculture share of total world production has also increased (FAO, 2000). Farm-raised fish pose a different set of food safety challenges than does wild-caught seafood. Farm-raised fish are subject to contamination from residues by production inputs (e.g., vaccines, feed additives, and antibiotics), whereas wild-caught seafood are more likely subject to contamination from, say, histamine (FDA, 2001).

Shifts in food consumption have led to some of these changes in food production, while other changes are driven by advances in technology and by comparative advantages of nations. Shifts in food consumption coincide with increased trade and changes in the composition of world agricultural trade (Regmi, 2001). Not only are trade volumes increasing—especially of fresh, minimally processed, or high-value foods—but countries like the United States are looking to imports for a wider variety of safe food year-round.

There is no scientific evidence that food imported into the United States, as a whole, poses greater food safety risks than domestically produced food (Zepp et al., 1998). Concern remains, however, for products such as seafood because more countries are exporting to the United States and some of these countries have poor internal control systems and/or are in tropical areas where toxin and bacteria hazards are intrinsically higher (Ahmed, 1991). In general, importing countries have limited ability to enforce their standards outside their borders and may view exporters' standards as inadequate or unreliable (Lichtenberg, 2003). Establishing the equivalence of another country's regulatory system is difficult (see chapter 3). Although risks from imported food sources are similar to the kind and extent of risks from domestic sources, the United States has less food safety oversight over countries from which we import, which are increasingly from developing countries.

In general, less developed countries are adapting to higher standards of food safety oversight as they enter new markets, and technical assistance helps with this. Often, higher standards apply only to production for export markets (see chapter 5). Both public and private sectors are helping to safeguard imported food. For example, private importers may set safety standards for imports over and above those set by the U.S. Government. However, reducing a residue tolerance, for example, does not necessarily provide additional protection from disease or injury. Governments in exporting countries may work with their industries to ensure food safety as well.

Although over a dozen Federal agencies share jurisdiction over food safety (e.g., education, enforcement, inspection, monitoring, outbreak management, research, and surveillance), four have major regulatory roles: the Food Safety and Inspection Service (FSIS) in the U.S. Department of Agriculture (USDA), the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), and the Department of Commerce's National Marine Fisheries Service (NMFS) (IOM, 1998).[2] These four agencies actively monitor imports and, in some cases, survey the safety of production abroad. In general, FDA oversees almost all import inspections, which include testing for pesticide residues or sanitary violations. Meat and poultry products fall under FSIS jurisdiction, and this agency carries out audits of foreign plants to ensure that sanitation meets U.S. standards. FSIS also re-inspects imports of these products using statistical sampling techniques to verify that exporting countries' inspection systems are working. FSIS and FDA share responsibility for egg product imports (IOM, 1998). For seafood, NMFS conducts a grading program and a voluntary inspection of fishing vessels, seafood products, and processing plants; FDA has regulatory responsibility for seafood safety, including imports (IOM, 1998). FSIS requires that exporting

[2] For FSIS, see *www.fsis.usda.gov*, for FDA, see *www.fda.gov*, for EPA, see *www.epa.gov*, and for NMFS, see *www.nmfs.noaa.gov*

countries have food safety systems equivalent to those in the U.S., while FDA lacks such authority, relying mostly on port-of-entry sampling to determine if imports meet U.S. standards (GAO, 1998).

With heightened awareness of food safety concerns and the rapidly changing food system, food safety standards are becoming more stringent and responsive to new hazards (see chapter 3). Countries that trade internationally may have different desired levels of food safety and food safety regimes, as well as different costs of complying with regulations. These differences may lead to trade conflicts or reductions in trade (see chapter 2). These differences may, on the other hand, lead to increased dialogue between countries and cause some to change or even improve their food safety systems.

## Who Manages and Ensures Food Safety?

Food safety, both domestically and internationally, is managed and ensured by both private and public sector efforts (Caswell and Henson, 1997).

### Private Sector

The private sector, both here and abroad, has strong incentives to prevent food safety crises and to mitigate their impact if they arise. Firms implicated in a crisis may suffer from reputation lost, stock prices reduced, plants closed for cleanup or permanently shut down, food poisoning lawsuits filed, premiums raised for product liability insurance, and demand for product reduced enough to threaten entire markets or industries (Buzby et al., 2001). For example, the Guatemalan raspberry industry shrank from 85 producers to 3 once caught in the spotlight of repeated *Cyclospora* outbreaks from contaminated raspberries (see chapter 5).

Many sectors have great potential for growth in world markets and so have added incentives to produce safer food (e.g., see chapter 4 on the growth of the red meat sector). As safety and quality attributes are increasingly demanded by consumers, the private sector responds.[3] For example, the seafood sector exhibits increased market segmentation, with wealthier countries favoring higher valued, safer products while less wealthy countries favor lower valued products with fewer food safety assurances (Wessells, 2002). In general, the private sector pioneers food safety advances. Firms such as Nestle, in fact, have developed food safety assurance standards beyond mandated ones (USDEC, 2001).[4] Importers often target their food safety efforts to sell to large supermarket chains with particular food standards (e.g., regarding produce).

For branded products, private-sector diligence may help firms improve their international competitiveness when their products are perceived to be noticeably safer. Private approaches fostering food safety include self regulation, vertical integration, third-party certification, and common approaches to risk identification, assessment, and management such as Hazard Analysis and Critical Control Point (HACCP) systems and voluntary guidelines or Good Agricultural Practices (GAPs). Vertical integration is growing in the United States and is characterized by a single firm controlling the flow of a commodity across two or more stages of production (Martinez and Reed, 1996). It can better guarantee the safety and quality of a firm's inputs and enhance the ability to trace product ingredients or processes back through the food production and marketing chain. Traceback capability is critical in the event of a food safety problem; it can help identify the source of the contamination. Tracing such incidents forward can eliminate other firms or products as potential sources of contamination (see chapter 5).[5]

Third-party certification provides assurances to consumers that the information supplied by firms is correct (Golan et al., 2000) (e.g., the International Organization for Standardization has its ISO 9000 series or "EN 29000" in Europe). HACCP essentially identifies, monitors, and controls hazards at critical points in food production and processing. Many producer groups have instituted quality assurance programs, and firms often use a mix of approaches.

[3] Although the Food and Agriculture Organization of the United Nations considers food safety to be one attribute of food quality, the U.S. Food Industry considers food safety and quality as separate attributes. Therefore, we follow the latter usage in this report.

[4] Of course, the amount of market share that firms can capture from increased food safety efforts will depend on how well consumers can distinguish the safer product, how willing they are to pay for the safer product, and how well firms communicate that their products are safer to consumers.

[5] Note traceback is different than traceabilty. Traceability is established when information about a particular attribute of a food product is systematically recorded from creation through marketing (Golan et al., 2002).

## Public Sector

Although the private sector has strong incentives to produce safe food, market signals to producers are imperfect. Consumers often cannot discern the safety of their food before buying it, and so their preference for safer food may not be reflected in the price they are willing to pay. Also, market transactions do not include all of the social costs of food safety (e.g., medical costs, lost work time) (Buzby and Roberts, 1997). Additionally, high transaction and information costs, combined with the structure of the legal system, limit the effectiveness of litigation for compensating ill consumers and providing firms with signals to produce safer food (Buzby et al., 2001). Therefore, in addition to private sector approaches, government regulation is necessary to ensure food safety.

New approaches to food safety regulation emerged in industrialized countries during the 1990s following advances in science, changes in markets, and increased awareness of food safety risks. There are seven main trends for food safety regulation in industrialized nations (see chapter 3). Regulatory agencies are increasingly:

- Organized into one agency that can focus on food safety,
- Using risk analysis to design regulation,
- Stressing a farm-to-table approach in addressing food safety hazards,
- Adopting the HACCP system as a basis for new regulation of microbial pathogens in food,
- Adopting more stringent standards for many food safety hazards,
- Adding new and more extensive regulation to handle newly identified hazards, and
- Improving market performance in food safety through provision of information.

These trends cut across commodities (see chapters 4, 5, 6, and 7). However, each food sector may also face unique issues, such as BSE in cattle and bovine products, histamine poisoning in seafood, and mycotoxin (toxic byproduct of mold infestations) risks in grains.

Different food safety standards and regulations naturally evolve around the world, even when countries have similar levels of economic development. For example, standards may differ because countries disagree about science—countries may have different scientific standards or they may interpret the same science differently. Food safety contamination can vary greatly among countries because of differences in available technology (e.g., refrigeration), plant and livestock host factors (e.g., herds exhibit varying infection rates, endemic diseases), food production practices (e.g., use of veterinary drugs), cultural differences (e.g., routine consumption of raw seafood), and geographic or climatic differences (e.g., colder climates may kill some pathogens) (Buzby and Roberts, 1999). These differences among countries may affect the relative risks or imports of food from different countries.

When the U.S. sets standards that affect imports or negotiates access to other markets with different standards, it does so under the rules set out by the Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures, which was established under the World Trade Organization in 1995. The SPS Agreement was a result of the 1986-93 Uruguay Round of Multilateral Trade Negotiations. This Agreement addresses food safety regulations and provides a framework for determining the legitimacy of regulations that restrict trade and for resolving potential trade conflicts. Under the SPS Agreement, WTO members recognize several principles, including:

- *Transparency*: Member nations are required to publish their regulations and provide a mechanism for answering questions from trading partners.
- *Equivalence*: Member nations must accept that SPS measures of another country are equivalent if they result in the same level of health protection.
- *Science-based measures*: SPS measures must be based upon risk assessments and must be chosen so as to minimize distortions to trade.[6]
- *Harmonization*: Member nations recognize the desirability of common SPS measures. Three international organizations are recognized as sources of internationally agreed-upon standards: the Codex Alimentarius Commission (Codex) for human health measures, the International Office of Epizootics (OIE) for animal and human health measures, and the International Plant Protection Convention (IPPC) for plant health measures.

[6] Risk assessments identify the sources and incidence of risks, and identify possible control strategies.

The SPS Agreement also establishes dispute resolution mechanisms. Because of improved transparency and the international SPS framework established for food safety, many disputes are diffused or resolved before reaching a formal dispute process. Several chapters in this report refer to the SPS Agreement, because it has played a role in the negotiation of trade disputes or potential disputes over food safety standards. For example, the emergence of BSE has created many difficulties for trade of live cattle and bovine products, and international organizations have helped prompt new standards to control BSE in the beef supply.

One area of controversy is the difference in food safety standards that exists among countries (e.g., mycotoxin risk assessments and standards, see chapter 6). Codex has facilitated the discussion of internationally acceptable standards, and the SPS Agreement has eased negotiations among countries concerned about new standards proposed by the European Union (EU) and by others. Food safety issues examined in this report for other commodities, such as produce, seafood, and poultry, have been addressed either through private efforts to meet standards or through bilateral negotiations over acceptable standards and systems of oversight.

In essence, the private and public sectors have responded to consumer demand for quality and safety by developing and implementing common approaches for quality and safety control, management, and assurance (Regmi, 2001), often working in partnership. The extent of public versus private responsibility varies among commodities and food products. Public and private approaches are often intertwined with each other and with multilateral coordination mechanisms (e.g., Codex and HACCP). For example, the public sector mandates HACCP for some foods, while the private sector voluntarily implements it for other foods. In another example, the fruit and vegetable sector is using third-party certification to reduce microbial and other hazards, and this certification is based on GAPs provided by FDA.

## How Do Food Safety Disputes in Trade Arise?

The dynamic nature of food trade, the emergence of new hazards, and remaining differences in regulatory approaches and capacity can still spur disputes over differing food safety standards. In particular, food safety disputes in trade may arise from the following (see chapter 3):

- The appearance of new hazards and/or increased trade volumes from new sources can lead to food safety incidents or disputes in trade (see chapters 4, 5, and 8 for examples);
- Rising standards and rapidly changing food safety regulations in industrialized countries can create challenges for developing countries (see chapters 5, 6, and 7 for examples);
- If new or more stringent standards are process standards, then it is more difficult to determine whether an equivalent safety outcome has been achieved (see chapters 4 and 7 for examples);
- Strong differences remain with respect to consumer risk preferences, consumer perceptions, and the role of non-science issues in regulatory decisionmaking (see chapters 3 and 4).

The causes of food safety and international trade disputes are complex and likely to persist for some time.

Recently, several new food safety hazards have disrupted trade. BSE, for one, emerged in the mid-1990s and instigated new regulations, some of which have proven contentious among trading partners (chapters 3 and 4). And the Belgian dioxin crisis temporarily suspended the trade of wide range of products (e.g., pork, cheese, and poultry) in many countries (chapter 8).

## What Food Safety-Related Trade Disputes and Challenges Arise in U.S. Commodity Sectors?

Health risks from internationally traded agricultural products outweigh risks from domestically produced products in at least one important respect—trade can spread pathogens, pests, and diseases into countries traditionally free of these hazards. In essence, animal, plant, and human health concerns with domestic agricultural products tend to stem from endemic pathogens, pests, and diseases, and the responses to these hazards are often established and ongoing. Hazards introduced through international trade may pose a whole new set of problems unfamiliar to the importing country. These problems may threaten trade and the economic health of the importing and exporting country. BSE, for example,

has affected a number of U.S. domestic industries even though there has never been a BSE case identified in the United States (chapter 4).

Food safety challenges are different across commodity and food types because of the nature of the products. First, it matters **whether the product is highly perishable**. The potential for faster decomposition means a shorter shelf life, greater food handling challenges, and fewer leftovers to test in the event of an outbreak. Raw foods tend to pose higher risks than cooked or processed foods and may be more likely to pose risks of cross contamination.[7] Animal products such as meat, poultry, seafood, dairy products, and eggs are the foods most likely to cause outbreaks of human illness in the United States (CAST, 1994, p. 32).[8] In recent years, the variety of foods associated with foodborne illness (e.g., salami, lettuce, bean sprouts, and raspberries) has increased (Tauxe, 1997), perhaps with improvements in detection and traceback. In particular, foodborne outbreak investigations are tracing a greater proportion of outbreaks to fresh produce (Tauxe, 1997). Less perishable foods such as grains tend to pose fewer acute food safety challenges (e.g., mycotoxins) (chapter 6).

Second, the **nature of the human health risks** associated with food matters. Do risks lead to illnesses that are acute or chronic, of low or high severity, and/or low or high incidence? The nature of risks determines how the risk is regulated and controlled, and its associated costs. For example, most food safety hazards from seafood, meat, and poultry are from the immediate health risks of ingesting foods contaminated with pathogens and their toxins, so regulation and testing tends to focus on reducing these kinds of contamination. On the other hand, human health risks from contaminated grain products generally stem from increased cancer risk due to long-term exposure to mycotoxins, so surveillance and prevention measures are aimed at these hazards. Food safety concerns from produce involve both the immediate health risks from pathogens and the chronic risks from long-term exposure to pesticide residues, and so testing is for both types of hazards.

Third, **whether the food safety issue is linked with productivity** in the commodity sector also matters. Meat and poultry are singular commodities in that their human and animal health issues are often linked. Some pathogens such as *Salmonella* and *E. coli* O157:H7 exist naturally in the gastrointestinal tracts of animals and birds (Wells et al., 1998). Some pathogens can impair the health of the animal, and contaminate meat and poultry during slaughter if the gastrointestinal tract is punctured or if the hides, feathers, and hoofs are contaminated when animals enter the slaughterhouse (IFT, 2002; Feinman, 1979). Animals fed mycotoxin-contaminated grain can become ill, which can lower animal productivity (weight gain, milk or egg production) (CAST, 2003). Animal byproducts must be destroyed if mycotoxin residue levels exceed standards (CAST, 2003). Mycotoxin levels are higher when crops are under stress or stored in improper conditions, so well managed crops would suffer less contamination and reduce waste. This improves the incentives for food safety diligence (CAST, 2003).

Fourth, differences in challenges across commodity sectors also depend on the **extent of vertical coordination and joint cooperation** among stakeholders in the sector. Well-developed mechanisms for coordination enhance the ability of a commodity sector to share costs and incentives arising from food safety improvements. Such mechanisms can also facilitate traceback and recalls if outbreaks occur. For example, grower organizations in produce have spearheaded traceback systems to protect the reputation of their particular crops (chapter 5). Without a rapid and effective system for traceback, sectors may face serious financial consequences if their products are erroneously implicated with a food safety crisis. For example, the California Strawberry Commission estimated that growers in the central coast of California lost $16 million in revenue during June 1996 when their products were falsely implicated with the *Cyclospora* outbreak later attributed to Guatemalan raspberries (Mishen, 1996).

Although food safety issues, challenges, and approaches differ among sectors, food safety incidents can compromise markets, market share, and business or product reputation across the board. All commodity sectors are concerned with protecting their product's reputation for safety in both domestic and international

[7] Although processing and refrigeration can kill or slow growth of some hazards in perishable foods, they do not result in zero risk. Some pathogens such as *Listeria* can grow and even multiply under refrigerated conditions, and some toxins and mycotoxins can remain harmful after cooking or processing.

[8] The extent of product co-mingling may also be important. For example, the nature of ground beef is such that one hamburger may contain meat from many cows and any existing contamination can be spread throughout a batch of hamburger, making thorough cooking even more important (chapter 4).

markets (see chapters 4 and 5). Furthermore, producers in all commodity sectors prefer to have regulations and standards applied in the same way to imports and domestic production, so that they can compete on an equal basis to provide safe food (see chapter 4 for an example of differential application of standards).

## Trade Frictions Over Food Safety Persistent but Surmountable

Food safety concerns and new food safety regulations in industrialized nations have led to trade frictions. Though all countries value food safety, the best means of ensuring it and the extent of control necessary is debatable—and is debated. For example, the United States and the EU have disagreed over both risk standards and methods of risk management (e.g., the role of scientific and economic analysis; level of product standards; risk equivalence of different process standards) (chapter 3). Such trade frictions can be persistent. For example, mycotoxin contamination is recognized as a risk that is difficult or impossible to control, and under the precautionary principle, some countries may set new standards on certain mycotoxins despite unclear scientific evidence about health risks (chapter 6).

Ultimately, facilitating trade without compromising consumer protection is an inherently challenging task (chapter 6). Any coherency between trade goals and food safety goals will likely incur private costs and/or public intervention and investment. International institutions are working toward harmonizing trade and food safety goals and the private sector is also contributing, particularly where market incentives are strong. When a food safety crisis arises, both governments and the private sector react quickly to minimize human illnesses and financial losses. With the *Cyclospora* outbreak attributed to Guatemalan raspberries in 1996, FDA, Health Canada, the Canadian Food Inspection Agency, and Guatemalan officials joined forces, while the Guatemalan Berry Commission developed a system to characterize farms according to food safety risks (chapter 5).

There has been remarkably little disruption to trade for food safety reasons, despite large increases in the volume, value, and variety of food trade. Global food and agricultural trade has increased from $138 billion in 1975 to $436 billion in 2001. For the United States at least, there is no evidence that food safety risks are correlated with trade volume.

Food safety can enhance trade as more prosperous consumers worldwide demand certain attributes, like safety. Both market share and value could grow for producers who can manage and certify quality and safety. Trade provides consumers with a year-round supply of a wider variety of food. If a food safety crisis does occur, international markets and crisis-free exporters offer a source of flexibility in satisfying demand.

Because the government and private sector have limited resources to devote to food safety, it is important to target them effectively. More research is needed to support priority setting. FDA product sampling is already targeted to products with higher risks to human health. But how to monitor and set standards for foods produced in different ways under different regulatory systems? Research might explore what kind of standards (e.g., process or product) provide for easier monitoring and assurance of food safety in trade and explore the relative cost of these standards.

Food sectors quickly respond and adjust food safety practices after food safety incidents (e.g., the private sector response to *Cyclospora* outbreaks). Meanwhile, consumers tend to adapt and regain trust in the food supply when new private/public oversight efforts are announced (or simply with the passage of time).

The complexity of food safety issues in trade means that disputes and difficulties will continue to arise. Nevertheless, the many similarities in regulatory approaches among industrialized nations may enable greater agreement about higher standards. As industrialized countries with major markets adopt new regulations, there is incentive for other countries to follow suit (Vogel, 1995). Furthermore, government can help the private sector allay food safety concerns, by providing guidelines for good agricultural practices (see chapter 5). Private certification of compliance with these guidelines can facilitate trade, even when standards and requirements differ among countries.

Food trade will continue to expand with growth in demand, increased market access, and reductions in technical barriers. Food safety enhancement is essential to consumer welfare and product reputation. Both U.S. consumers and producers have an interest in seeing improved food safety and expanded food trade. This report highlights the issues that must be managed if this is to happen.

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*Chapter 2*

# Economic Theory and Conceptual Relationships Between Food Safety and International Trade

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## Summary

The market has incentives to provide some degree of food safety, as firms depend on their reputations for repeat sales. However, the market generally does not provide the socially desirable amount of food safety for two reasons. First, consumers cannot determine how safe food is before buying it. Even when consumers purchase foods, they often cannot tell whether a particular food was responsible for making them ill or whether consuming it might have long-term health consequences. Food safety measures can increase costs for firms, and this lack of information reduces the incentives for a firm to provide safe food. Consumers will not necessarily be able to assign the appropriate credit or blame to firms that provide safe and unsafe food respectively. Indeed, when consumers learn of a food safety incident and the unsafe food cannot be attributed to a particular firm, consumers might simply stop consuming that type of food altogether.

Second, when consumers eat unsafe food and become ill, costs extend beyond consumers themselves to healthcare workers, employers, and family members. Consumers don't usually take these costs to others into account when they consume food. Thus, society would like consumers to devote even more resources to making certain that their food is safe in order to avoid these extra costs.

Government regulation is an attempt to increase the amount of food safety provided by the market, as the market alone will usually not provide the socially desirable level of food safety. Regulations can specify particular processes that a firm must use to produce food, or they can simply specify a level of safety for the final food product. The latter are generally considered more efficient, as they allow the firm to select the least expensive method of arriving at the desired product. Regulations often raise costs for firms, but consumers are often willing to pay more for safer food. However, firms might have a difficult time communicating improved safety to consumers.

When countries trade internationally, the same issues arise, with a few additional concerns. Regulations might differ across countries, as countries have different types of regulations, different levels of tolerance for food safety risks, different costs of producing safer food, and different levels of accidental contamination. If a regulation imposed by the government of one country is more stringent, its firms will have higher costs and may be unable to sell their goods as cheaply as foreign firms not subject to the regulations. Consumers will pay more for safer food, but the firm's ability to communicate its food safety level—and the consumers' inability to take social costs into account—can leave the domestic firms at a disadvantage. These regulatory differences can create conflicts across countries.

When countries disagree over food safety regulations for imports, several outcomes can occur. The domestic country can ban less regulated foreign foods. If the foreign producers really cannot provide the safer food as cheaply as domestic firms, this could benefit consumers. However, if foreign firms could provide food that is cheap and safe, consumers lose from a ban. If the foreign firms decide that the value of the domestic country's market is high enough, the foreign firms can adopt the domestic country's costlier food safety regulations. If these regulations spread throughout the foreign country's industry, this can improve food safety for the foreign country's own consumers. Finally, the countries can negotiate their way to a compromise solution, if both feel that the costs they must incur are worth the benefit of maintaining the trading relationship.

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# Introduction

This chapter discusses the basic economic theory behind food safety regulation, and its predicted effects on trade. Food safety issues are becoming increasingly important in the arena of international food trade. As countries begin to lower agricultural tariffs and become increasingly integrated into world markets, they purchase more food from abroad. As consumers grow wealthier, they also focus more on the attributes of their food, its safety, nutrition, and environmental friendliness. Increased income can mean an increased willingness to pay for such characteristics.

Consumers demand food safety, and food producers are willing to provide it. However, consumers often lack information about products that they buy, and might not consider social costs, like lost workdays resulting from a foodborne illness, in their purchasing decisions. This incomplete information, coupled with the costliness of some food safety provisions, can mean that the government needs to regulate food safety.

Indeed, most nations have laws that regulate the safe production of food within their borders, but no country has jurisdiction over production outside of its borders. A country can regulate the products entering its borders, but enforcing these standards is difficult and costly, as it requires sampling and testing many shipments. Consumers therefore consume not only food from abroad, but also the services of other countries' food safety regimes. The desired level and form of food safety regulation may vary among countries, and exporting firms might have difficulty complying with multiple safety regimes. Differences in food safety regulations can lead to trade conflicts, but can also lead to increased dialogue on food safety standards. Some conflicts over food safety lead to reductions in trade, while other conflicts are settled amicably. Sometimes, conflicts can even lead to improvements in food safety, as firms comply with the stricter safety regimes of their trading partners.

# Demand for Food Safety

## Food Safety is Valued by Consumers

Consumers value a safe food supply. Since food is a necessity, consumers value knowing that their food is free of toxins, foreign material, and pathogens. Food safety concerns have increased as wealth has risen. Now that many consumers in the industrialized world have adequate quantities of food, they (or their governments) can spend resources to ensure that their food is safer. For example, Hayes et al. (1995) found that U.S. consumers were willing to pay a premium of 15 to 30 percent per meal to reduce their risk of becoming ill from their meal, while a number of studies cited by Baker (1999) found that consumers are willing to pay a premium for reduced pesticide residues in produce. Another study found that the premium consumers were willing to pay for food with low pesticide residues increased with income (Huang et al., 2000, 1999). In a number of experiments and surveys, consumers have indicated that they would be willing to pay more for food with lower risks of disease; however, these experiments might not reflect how consumers will actually behave in a market setting, as consumers' attitudes on surveys sometimes differ from their documented behavior at the cash register (Caswell, 1998). Food safety scares, like the Bovine Spongiform Encephalopathy (BSE or "mad cow disease") problem in the European Union (EU), or the *E. coli* outbreak in the Western U.S., have raised awareness about food safety issues. Additionally, food travels long distances from producer to consumer, and many foods are perishable. Modern food processing facilities, refrigerated transport, and research on temperatures, pathogens, and toxins have all improved food safety. As consumers know that such technologies are available, they will likely hold producers to a high standard.

## Consumer Demand Reflects Only Some Benefits of Food Safety

Consumers can lack adequate information about their food purchases, preventing them from demanding the level of food safety they would choose if they had complete information.[2] Additionally, even if consumers have adequate information, their individual purchases may not reflect the desire of the wider society for food safety.

[2] When an economic agent does not know which of several possible outcomes (safe food, unsafe food) will result from a transaction, economists say the market is characterized by *imperfect information*. When one party to a transaction does not know as much about the good being exchanged as the other does (for example, a consumer does not directly observe how meat is handled), economists say the market is characterized by *asymmetric information*.

### *Food Safety Is Not Always Observable*

Consumers cannot always readily observe the safety level of their food. A consumer usually cannot know whether food is contaminated until after purchasing it (Segerson, 1999; Caswell, 1998). Even if the consumer becomes ill from eating food, linking the illness to a particular food out of many consumed is often difficult (Segerson, 1999; Buzby et al., 2001; Caswell and Mojduszka, 1996). Indeed, if the food is contaminated with toxins, like carcinogens, the consumer might be not be able to observe any adverse effects for many years, if ever, and might not be able to attribute any adverse health consequences to a particular food (Antle, 1996).[3] Thus, firms have less incentive to provide food safety than they would if food safety were directly observable by the consumer prior to purchase.

### *Consumers Don't Consider Food Safety Effects on Society as a Whole*

Consumers may not demand as much food safety as would be *socially* desirable, neglecting to take all the social costs of their purchases into consideration (Segerson, 1999, Golan et al., 2001). Inadequate food safety can result in illness, which imposes private costs on the consumer, but which also creates social costs in the form of additional resources allocated to medical care and lost workdays. For instance, outbreaks of *E. coli* O157:H7 in fast food restaurants during the early 1990s created clusters of illness in several Western States, with over 700 people affected. Several victims died, and many patients experienced pain and suffering. Some spent costly stays in intensive care units or visited emergency rooms, and some might experience lifelong health problems, with long-term implications for health-care resources (Buzby, 2002; Foulke, 1994). In such cases, the patients' relatives had to put aside other activities in order to care for them. In addition, public health resources had to be mobilized to trace the source of the outbreak.

Thus, health care resources, employers, and other sectors of the economy share the costs of inadequate food safety with the original consumer of the unsafe food. This reduces both producers' incentives to produce safe food and consumers' incentives to consume safe food, because neither group bears the full costs of their actions. Even if producers matched the food safety they provide with the amount that consumers demand, a more socially beneficial outcome would occur if producers' provision of food safety met the demand of consumers plus the demand of health care resources, employers, public health departments, and other affected sectors of the economy.

[3] When a good has a characteristic (e.g., overall effects on longrun health) that is not directly observable even after the buyer has purchased and consumed it, economists refer to that characteristic as a *credence attribute*.

## Implications of Food Safety Demand for Firms

Since consumers demand some degree of food safety, firms have an incentive to supply safer food (Holleran et al., 1999). Reputations for providing safe food are valuable assets that firms have an incentive to protect. A firm can develop an edge over its competitors if it produces food using a technique known to enhance food safety (Reardon and Farina, 2001). Likewise, a firm can suffer increased costs or a loss of sales and equity, sometimes permanently, if someone becomes ill from eating one of its products (Buzby et al., 2001; Dolan and Humphrey, 2000; Henson and Northen, 1998; Segerson, 1999; Thomsen and McKenzie, 2001). Odwalla, a "natural" juice company, lost millions in sales and suffered a stock price decline of 68 percent when customers contracted *E. coli* from drinking its apple juice (Buzby et al., 2001; *San Jose Business Journal*, 1997). In another instance, Perrier, a leading mineral water company, lost 50 percent of its U.S. market share when one of its shipments was contaminated with benzene (Kunreuther and Slovic, 2001). Richards and Patterson (1999) find that negative publicity about the safety of a food product has a very persistent effect on prices.

### Food Safety Can Be Costly to Supply

Implementing food safety standards can increase costs for firms. If food processors need, for example, to increase the cooking temperatures for their foods, they will need to pay more for energy, and will need to cook each unit of product longer, perhaps raising labor costs. If firms are required to use sterile packaging, they might have to add more steps or inputs to their assembly line. If certain pesticides are banned, farmers might have to use less effective ones, thus losing a larger percentage of their crop to pest damage.

However, some standards might not raise costs much at all. For example, some of the more toxic pesticides can be replaced with less toxic ones for similar prices. Jensen et al. (1998) found that improving food safety in

the meat industry raised costs for producers and that costs varied with the particular safety option chosen. Antle (1999) cites a number of studies that quantify the costs of complying with various food safety regulations. Ollinger and Mueller (2003) find that implementing HACCP (Hazard Analysis and Critical Control Points) systems in meat-processing plants added just under one cent per pound to the cost of meat processing.

Firms have incentives to protect their reputations, and so might implement state-of-the-art food safety practices without any prodding from the government. Additionally, as consumers might be willing to pay more for food that they perceive as safer, firms have another incentive to implement food safety regimes. The higher prices consumers are willing to pay could compensate firms for the costs of food safety provision. A firm will adopt more stringent food safety practices if the cost is smaller than the resulting benefit to the firm in the form of reduced risk of losses, reduced liability, and higher consumer willingness to pay for the safer food.

Increasingly, food producers in wealthy countries engage in long-term contracting with their suppliers, and carefully vet those suppliers for food safety compliance. Some firms use international and third-party standards and certifiers in order to reduce the costs of verifying that suppliers are using safe production methods and to reduce the costs to suppliers (Henson and Northen, 1998). Segerson (1999) frames the problem slightly differently, noting that a firm will voluntarily improve food safety standards if the benefits to the firm, plus the decrease in damages a firm would have to pay to injured consumers from selling the safer food, outweigh the costs that the firm will have to pay to implement new safeguards. If the cost is greater than these benefits to the firm, firms might not adopt more stringent practices unless the government mandates them.

## Imperfect Information Changes Incentives and Costs

Food safety levels are difficult to observe, and this can change the incentives for firms. If the firm perceives that consumers underestimate the chances of a food safety incident, then firms will produce more of the unsafe food than consumers would desire to purchase if they knew the risks (Segerson, 1999). Producers have less of an incentive to provide information about their products if they believe that consumers perceive the products to be less harmful than they actually are (Zarkin and Anderson, 1992).

A special case of this inability to identify the source of illnesses occurs when a food safety problem is identified with a particular bulk product or products from a particular country. If a product produced by a particular firm makes some people ill, but that particular firm's goods are hard to identify in the marketplace, consumers may eschew all products in that category (chapter 5). This, in turn, can reduce other firms' desire to provide safe goods. Even if the other firms spend a great deal to provide safe food, consumers still might not buy their products if they cannot tell the difference between the safe products and the unsafe one produced by the firm with the lower standards. The firms spending money on food safety will not be compensated for their extra expenses by increased consumer demand or willingness to pay for their safer products (Akerlof, 1970; Antle 1996).

In chapter 5, Calvin notes several cases in which a particular type of fruit supplied by a particular supplier caused illness. In these cases, demand fell for that fruit across all suppliers, not just the one implicated in the food safety crisis. For instance, when imported strawberries caused an outbreak of salmonellosis in 1997, U.S. strawberry producers suffered a decrease in sales, despite the fact that their product was uncontaminated; the same happened to U.S. cantaloupe producers. In such cases, firms can take safety precautions and still suffer reduced demand; likewise, firms that do not take safety precautions impose costs not just on themselves, but on other firms as well. A firm might therefore think that safety precautions are not worth the costs, whereas they would be worth the costs if firms were responsible for the costs they impose on their fellow firms by damaging the reputation of the industry (Segerson, 1999).

Because consumers perceive a product generally, rather than a specific firm's product, as safe or unsafe, firms might find it in their best interest to implement safety standards for the industry as a whole (chapter 5). Industry standards are probably easier to achieve among a small number of firms. Coordination costs are kept to a minimum. Additionally, if some firm does not comply with the standards and sells unsafe food, the source of the food safety crisis is easier to pinpoint. With many firms, just negotiating a set of standards might be problematic, and enforcing the regulations might be more difficult if the source of unsafe food cannot be traced to a particular firm out of the many in the industry.

Even if a particular food product can be identified as the source of a food safety problem, several companies might have handled the product. A package of cheese might have been produced by one firm, shipped by another, and sold to the consumer by yet a third firm. If the cheese contained an unsafe number of pathogens, it might be difficult to determine whether the contamination resulted because the cheese was packaged improperly, or because the shipper or the retailer stored it improperly. This difficulty in assigning responsibility could again reduce the incentive to provide safe food.

Additionally, if the cheese is associated with the brand name of one of those firms, the other two are more insulated from the negative effects on their reputations, because the market will not effectively route demand away from their firms to other, safer firms. In such a case, the firm whose reputation is on the line would be willing to pay to have the other two firms provide adequate safety standards. Indeed, Henson and Northen (1998) note that this is the method preferred by UK retailers, who sell many items under their own name brands and therefore have a great deal to lose in liability and reputation if a food safety incident occurs. However, the unobservability of food safety makes it difficult for the firm that cares about its reputation to be certain of the work of the other two without carefully observing the whole production process. Therefore, they note, many retailers are asking suppliers for third-party certification of their production facilities, which reduces the monitoring costs for retailers.

Indeed, even in cases where firms might wish to provide food safety to their consumers, it is frequently difficult for them to do so, since they themselves find it hard to detect unsafe food. There are many types of food safety hazards, and contamination can occur at many different stages. Pathogens can also multiply over time, causing the danger to increase (Unnevehr and Jensen, 1996).

## A Gap Exists between Socially Desirable and Market Outcomes

While economic theory suggests that firms should have an incentive to ensure that their products are safe from pathogens, toxins, and other hazards, these incentives are not always as strong as they need to be. The market outcome—that is, the intersection of supply and demand—can fail to achieve the efficient or socially desirable amount of food safety in two ways. The first source of market failure stems from the lack of consumer information. The market supplies the level of safety that consumers can currently observe, not the level of food safety that consumers would want if they could observe all of the safety attributes of their food. In such cases, the market might produce too much of the unsafe food, and too little of the safe food.

The market's failure to provide the efficient level of food safety information can have substantial consequences. If consumers become concerned about the safety of the food supply, or particular food items, they will reduce their consumption of such items, thereby shrinking the food sector, or parts of it, below the amount of food that consumers would prefer to consume if they had adequate information about the safety of their purchases, and could tell the difference between safe and unsafe food (Akerlof, 1970). Also, if consumers are unable to evaluate the true risks of food consumption, they can experience more illness and incur more costs than benefits from consuming some foods. Henneberry et al. (1999) found that the amount of negative information that consumers received about pesticides on produce reduced the demand for some varieties of produce and increased the demand for others. Thus, consumers' concerns changed the composition of their diet, altering the pattern of production and consumption from what it would be if consumers had more information.

The gap between society's ideal level of food safety and that which consumers demand for themselves constitutes a second source of market failure. Ideally, society would like food safety to be provided to the point that reflects consumer demand for food safety, plus the demand of public health providers and employers for food safety. However, producers only have incentives to take consumer demand for a particular product into account, not the demand of the rest of society, as consumers' willingness to pay determines the price that the producer receives.

Countries as a whole incur substantial costs when food safety incidents occur. One USDA study indicates that five types of foodborne illness collectively cost the U.S. $6.9 billion in 2000 (Roberts, 2001). Another USDA study, using simulations, indicates that implementing the Hazard Analysis and Critical Control Points (HACCP) program to reduce foodborne illness in meat and poultry resulted in economywide gains of $9 billion, not including the benefits of reduced work days lost (Golan et al., 2000). Another study estimated that the benefits of implementing HACCP policies would be $7-$42 billion (Crutchfield et al., 1997).

These estimates generally exclude some costs, like pain and suffering and public health agencies' expenditures on foodborne disease.

## Potential Ways to Close the Gap

### Litigation

Consumers, and sometimes other members of society, can attempt to recover some of the costs of unsafe food from food producers by seeking redress through the court system. In countries with a functioning tort system, a party who is injured by consuming unsafe food can sue the firm that produced the food for damages (Antle, 1996). Such suits should provide incentives for firms to provide safer food rather than risk the court costs, damage costs, and negative publicity of a lawsuit, but the incentives are limited by the difficulty of proving conclusively that a producer's food caused the illness.[4] Buzby et al. (2001) found that one-third of jury trials in food poisoning cases resulted in verdicts in favor of the consumer. Most cases were settled before they reached trial.

### Education and Information Provision

Governments can use food safety education as an alternative to regulation. Requiring firms to disclose information about the foods they produce and educating the public about food safety could allow consumers to make better choices about the foods that they consume (Caswell and Mojduszka, 1996). Van Ravenswaay and Hoehn (1996) note that publicly provided information on food safety could result in changes in consumers' purchasing behavior and food preparation practices that would reduce the number of food safety incidents. Labeling and education would address the consumer's lack of information, which is one of the market failures that leads to food safety problems (Caswell and Mojduszka, 1996). However, education would not address the second form of market failure—that consumers demand less food safety than society would like (Golan et al., 2001).

[4] Buzby et al. (2001) note that plaintiffs were hindered by long incubation periods for foodborne illness, a lack of food evidence, inadequate laboratory test results, and the fact that it is difficult to pinpoint which of many foods consumed caused the illness.

### Government Regulation

When markets and legal institutions fail to provide the socially optimal level of some good, like food safety, economic theory suggests that governments can bridge the gap. Governments can take a number of policy initiatives to induce producers to provide higher levels of food safety. Governments could, in theory, tax unsafe food, raising the firm's costs of providing unsafe food and therefore creating an incentive to provide safer food. However, this assumes that a society can measure the amount of unsafe food that is sold, which would be difficult. Most governments, therefore, turn to regulation, setting minimum safety standards that food producing firms have to meet before they can sell their products.

Regulations are generally classified as product standards and process standards. *Product standards* specify characteristics that a product must attain before it is considered safe to sell. For example, most industrialized countries have maximum residue levels (MRLs) for pesticides. If a food has pesticide residues above this amount, a vendor cannot legally sell that food. In Great Britain, the government, under the doctrine of due diligence, assigns the responsibility for verifying food safety to food retailers, rather than setting specific procedures for processing foods.

*Process standards* specify techniques that must be used to process or package foods, with the belief that certain production techniques make food more likely to be safe. For instance, some governments require that processed meat products be raised to a certain temperature to kill bacteria before packaging. Ideally, such process restrictions are based on research, like studies of the percentage of bacteria killed at each temperature. In practice, such studies are not always available, although knowledge in this area is increasing rapidly.

Governments might have motives beyond food safety for certain regulations. Some food safety regulations also achieve some other purpose, like protecting the environment, animal welfare, or worker welfare. For instance, DDT was banned in the 1970s not only because the residue on foods was considered dangerous for consumers, but because the pesticide also bioaccumulated. Small animals ate sprayed plant life, fish that lived in streams absorbed runoff from farms, and larger animals that ate these small animals and fish accumulated huge quantities of the toxin in their tissues. In particular, eagles and other birds of prey were threatened by DDT, and since the ban, their populations have

recovered a great deal (Muir, 2001). In this case, a process standard (banning a particular production process) was used; simply setting a residue standard for food might not have met the environmental goal.

## The Effect of Government Regulation on Supply

Are certain standards more costly than others? Economic theory indicates that product standards are often cheaper to implement than process standards, as product standards give firms more flexibility to choose the least costly production methods that meet the standards (Unnevehr and Jensen, 1996; MacDonald and Crutchfield, 1996). For instance, if a firm is told that its products cannot exceed a certain maximum level of pesticide residue, then it can choose the most cost-effective method for attaining that standard, which could include reducing the amount of pesticide applied, reducing the number of applications, switching pesticides, or altering the last date of application before harvest. If the government told the producer which of those methods to use, the government might not select the lowest cost method (Segerson, 1999). Indeed, one production method might be the low-cost method for one firm, while another method might be cheaper for another firm (Antle, 1996).

However, this general principle is not true in all cases. If one herbicide is banned because it is deemed too toxic, then producers might be able to switch to a similarly priced alternative. Additionally, standards for final products must be verified in some way, either by inspection or testing of samples, both of which can be costly, particularly in the case of pathogen contamination (Unnevehr and Jensen, 1996; MacDonald and Crutchfield, 1996). Hence, the relative expense of process and product standards has to be evaluated case by case.

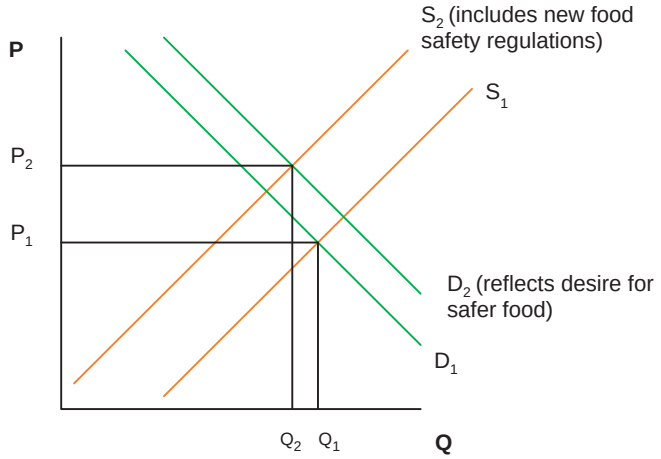
In response to the relative expense of these types of standards, many countries are adopting HACCP requirements, which require firms to identify points in the production process where food safety is likely to be compromised, and to put in place procedures that prevent such compromise. HACCP requirements feature characteristics of both product and process standards. Firms must adhere to the procedures in their HACCP plans, but are allowed to define those procedures. Firms must also meet standards for pathogens in their products, and testing is required. Such plans have proven to be cost-effective (Henson and Caswell, 1999). These plans allow the firm to choose the most cost-effective methods of prevention, and prevention can be less expensive than testing or remediating a product (Unnevehr and Jensen, 1996). Both the U.S. and the EU require producers of certain food products to implement HACCP plans.

Whatever type of regulation the government chooses, most regulations will increase production costs for at least some firms. In isolation, these cost increases generally shift back the supply curve of a firm, which results in a new market equilibrium where firms produce fewer goods at a higher price. One could also say that less safe food was overproduced before the regulations were put in place, since the production costs that firms paid did not reflect the true cost to society of the less safe food, which should include the costs of illness, lost workdays, and other costs to society. Sometimes, industry opposes individual government regulations, which can increase costs and reduce production.

With regulation, however, consumers would be more willing to buy the food products, since they are now getting a safer good for their money (Unnevehr, 2000). This represents a shift out of the demand curve, with consumers now willing to buy more of the safer food and to pay a higher price. Indeed, fresh milk sales in the U.S. are probably much higher than they would be if consumers did not have the security of knowing that milk is pasteurized. However, the individual consumer is not able to capture all of the benefits of having the safer food; some of these benefits go to society. Therefore, in some cases, consumers might not be willing to pay as much as it costs for the product to meet the most socially beneficial safety standard. In such cases, the net effect would be a decrease in sales with a higher price, although this higher price better represents the true cost of supplying the food product with the higher level of food safety (fig. 2.1).

Additionally, firms have difficulty in passing on the information about food safety improvements to consumers. Some firms advertise when they undertake an improvement in food safety, even when such an improvement is a response to stronger regulations. After the *E. coli* O157:H7 incidents in the 1990s, some fast food chains sent out press releases announcing that they would be increasing the mandated cooking temperatures for their beef. Many juice companies now advertise the fact that they pasteurize their products. Firms are only required to label juices if they are unpasteurized, but firms label their pasteurized juices to reassure the consumer.

Figure 2.1
**Market impact of a food safety regulation**




Firms might also try to obtain third-party certification as evidence that they are complying with a particular set of safety standards. In other cases, particularly if the public is not aware of a food safety problem prior to the implementation of a regulation, or is unaware of the magnitude of the incremental increase in safety, then the regulation might not result in an increase in demand for the new, safer product.

Food safety standards affect not only the industry in which they are implemented, but also other related industries. If prices of a particular food rises, consumers might consume less of that food and increase their demand for another food, which will alter that second food's equilibrium price (MacDonald and Crutchfield, 1996). Suppliers to that industry might also find themselves subject to more stringent standards (Henson and Northen, 1998). Thus, the regulations might affect not only the market equilibrium in the regulated industry, but markets in other industries as well.

Food safety standards can also have implications for industry structure. If regulations require a large initial expenditure on equipment, such regulations might give a cost advantage to large firms that can afford this expenditure, and their scale means that the additional cost per unit is amortized over a large number of units (MacDonald et al., 1996). Firms might also integrate vertically (with retailers becoming processors and/or processors starting to run farms) in order to better control food attributes. Results here are mixed. Henson and Northen (1998) report that retailers tend to prefer asking processors for outside certification, as opposed to running processing firms themselves. Kilmer et al. (2001), however, report that vertical integration among strawberry producers is associated with lower pesticide residues, but the same is not true for tomato producers.

In order to decide whether or not to enact a particular food safety regulation, governments must weigh the costs to the firms and the consumers who now pay higher prices against the benefits to consumers, employers, and public health resources of improved food safety. Henson and Caswell (1999) point out that many governments have found this assessment difficult to achieve, given the wide array of standards to evaluate and the myriad of grounds on which those regulations are based.

## Trade Implications

We have seen how concerns about food safety affect the domestic food production sector. Concerns about information, incentives for firms to provide food safety, and deviations of market outcomes from desired outcomes all affect the price, quantity, and qualitative attributes of food supplied. Firms may incur extra costs. Government regulation may prove necessary. How do those factors change when we introduce international trade into the picture?

Food safety concerns have some of the same implications for international trade as for domestic trade, but with the added complication that consumer preferences and government regulations may differ from country to country, creating the potential for rivalry and conflict. The 190 or so countries of the world all have established different regimes for food safety, and thousands of different foods are regulated. Differences in trade regulations can put either domestic or foreign firms at a competitive disadvantage in selling their products. Trade conflicts frequently result when countries enact different types of regulations, have different desired levels of food safety, or have different costs in complying with regulations. Countries can resolve these conflicts in a number of ways, including ceasing to trade, adopting each other's regulations, or recognizing each other's regulations.

### Demand for Food Safety

Consumers throughout the world desire a safe food supply. However, the extent of that desire might differ from country to country. Consumers are also generally willing to pay more for safer food, but the amounts they are willing to pay might differ. Consumers in very poor countries might have to balance expenditures on

other health threats against that of food safety. Wealthy countries therefore sometimes have more stringent standards for pesticides and microorganisms than developing countries do.

Consumers might have different desired levels of risk. One country might want to push risk as close to zero as possible, while another might regard some slightly higher level of risk as acceptable, because driving the risk to zero would be extremely costly. Economists have found that the desire to tolerate risk varies significantly across individuals. Men tend to be less "risk averse" than women (Jianakopolos and Bernasek, 1998). Wealth tends to increase risk aversion up to a certain level, after which risk aversion declines with wealth, while the opposite is true for age (Halek and Eisenhauer, 2001). One's perception of risk also depends on one's ability to mitigate the risk or to cope with an adverse outcome (Smith et al., 2001). To the extent that such factors differ across countries, willingness to tolerate risk differs. Some studies of asset markets have found different levels of risk aversion in different countries (Hamori, 1998). Further, countries might have similar valuations of risk, but might disagree on what to do when the risks are unknown.

Consumers might also have difficulty making evaluations at very low levels of risk, which might lead to very different standards in different countries.

## Implications for Firms

Firms still have incentives to provide safe food to consumers, even if those consumers are in a different country. Indeed, Holleran et al. (1999) note that there are incentives for foreign firms to provide safe food to capture international market share, just as there are incentives for firms to provide safe food to maintain domestic market share. If that incentive to provide safe food is large enough, firms might establish their own standards. This can be true as firms begin operating in an international arena as well. Firms can sell food abroad in one of two ways. They can open processing plants in other countries (often called foreign direct investment), or they can ship their food abroad (international trade). Raw and bulk food is often shipped. Some processed food is shipped, but a great deal is manufactured under license or by a subsidiary in the country to which the firm wishes to sell.

**Foreign direct investment.** As food processing firms open plants in many different countries, their private standards might be modeled after their production facilities in wealthy countries (Reardon and Barrett, 2000). Nestle, for instance, sets stringent standards for suppliers to its plants that operate in a number of developing countries (USDEC, 2001).

These internal standards stem from the fact that firms desire reputations for food safety (Reardon, 2001). It is sometimes costly to communicate food safety attributes to the consumer, so firms might rely on their international reputations to do so (Reardon et al., 1999). However, since most of the food processing firms began in nations with stringent safety standards, the firms might simply be adopting stringent standards for their worldwide operations to reduce transaction costs by having standardized procedures. Whatever the reasons, the firms from wealthy countries that open branches in other countries usually do so to produce for the host country's market, so the production at those facilities generally is not traded. The host country also has the legal right to impose food safety standards on these foreign-owned processing plants operating in their country.

**Trade.** Improving food safety standards can increase costs for firms. In addition to more expensive methods of production associated with food safety standards, trade also comes with some extra costs. Verifying that foreign countries have actually adopted the domestic food safety standards can be quite costly. Sending inspectors abroad is expensive, limiting the number of inspections an importing country can perform. If domestic governments inspect foreign firms, they can bear the costs, or they can bill foreign firms. If governments require foreign firms to obtain third-party certification, the costs will be borne by the foreign firms, but could be passed on to domestic consumers.

Foreign firms undertaking trade also undertake several risks as well. If compliance with the regulations requires a lot of fixed investment costs in the form of new equipment, foreign firms risk the investment without certainty of obtaining certification. In addition, even if they undertake certification, they might experience random transitory events, like disease outbreaks, that prevent them from complying with their trading partners' food safety regulations for short periods of time.

The same problems that lead to a need for regulation domestically can lead to a need for government regulation in the international trade environment. Consumers do not consume as much safe food as society would like them to. Consumers also lack information about the safety level of the foods they eat, and the inability

of consumers to distinguish between safe and unsafe food can reduce the incentive for firms to provide safe food. Consumers might assume that if one firm's product is unsafe, all brands of that good are unsafe.

In the international arena, there are two complications to add. A firm's products might be labeled unsafe if some other firm has produced unsafe versions of that product, even if that other firm is in another country. California berry producers suffered a reduction in demand when consumers became ill from eating berries grown in Guatemala (chapter 5). Consumers could not differentiate the safe berries from the unsafe ones. Additionally, firms located in particular countries can find that their country's reputation matters in determining whether they can sell their goods abroad. Several studies indicate that consumers form opinions about the general quality of goods coming from a particular country (Chisik, 2002). When consumers receive inadequate information about the products they purchase, they can make errors that reduce their welfare, eschewing products they might really want to buy and embracing products that might be unsafe. Firms therefore lose some of their incentive to provide safe food, since they can spend money on food safety and still lose sales as the result of an outbreak. Conversely, they can spend little on food safety, and might not lose as many sales as they would if consumers knew their food was less safe. If a country's goods are perceived as poor in quality, there is less incentive for firms in that country to improve quality if they don't believe they can convince consumers to pay them the high quality premia (Chisik, 2002; Basu and Chau, 1998).

## Government Regulation in the International Arena

These information shortcomings generally lead governments to regulate food safety. However, in the case of international trade, each country enacts its own unique set of food safety regulations. A country's ability to regulate firms outside its borders is limited to import restrictions. These differences in food safety regulations across countries can create conflict.

If governments impose regulations on domestic firms, and such regulations raise costs for producers, then producers might suffer a loss of sales. This problem can be compounded in the context of international trade. If domestic producers must adhere to regulations that raise costs of production, but foreign firms do not have to meet the same requirements, then the foreign firms can offer their products at lower prices, undercutting the domestic firms and capturing a larger market share. Although consumers are willing to pay more for a safer good, if they cannot distinguish between the more heavily regulated, and presumably safer, domestic good and the less regulated imported good, they will not be willing to pay what the safer good is worth to them.

The amount of market share that foreign firms capture will depend on how willing consumers are to pay for the safer product, how well they can distinguish the safer product, and how well firms communicate to their customers that their products are safer. Figure 2.2 illustrates the case where the foreign supplier is not bound by the new stringent food safety regulations, but domestic producers are, so that the new domestic supply curve reflects higher costs.[5] The demand curve remains unchanged, reflecting the assumption that consumers are only willing to pay more for a safer good if they can identify it. The result is a loss in market share for the domestic firm, and an increase in the cheaper imports. In such cases, consumer groups interested in food safety and domestic producers sometimes form political coalitions to pressure the government to impose the same standards on foreign firms as domestic firms (Vogel, 1995).

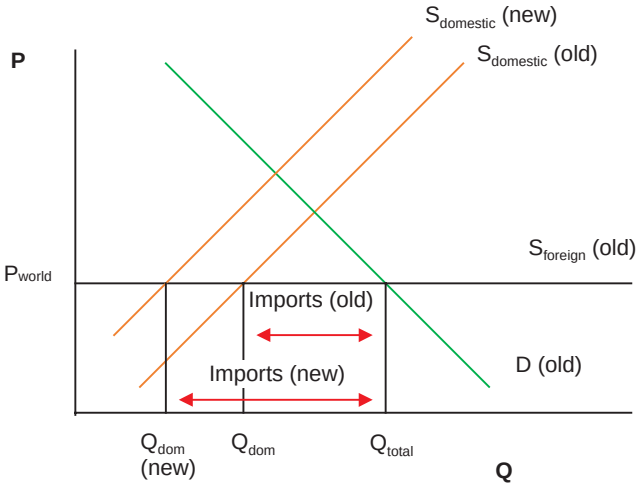
Indeed, governments already have a motivation to impose such standards, namely a safe food supply, whether foods are domestically produced or imported. Since governments do not have the power to regulate production in other countries, they usually set standards for imports that require foreign producers to meet the same product standards that domestic firms must meet or to prove that they use the same production techniques required of domestic producers. Foreign firms then have to pay the higher costs of complying with the standards, and might have to raise their prices, making their prices more similar to those of domestic firms.

Some governments have even set standards for particular foreign products higher than those for like domestic products. The foreign firms then must pay the higher costs of complying with the more stringent standards, and might have to charge a higher price than domestic firms. The foreign firms might even be kept out of the market altogether. Chile, for instance, has banned the import of fresh poultry. However, domestic firms are allowed to sell fresh poultry (see chapter 4). This prac-

[5] Figures 2.2-2.3b reflect the assumption that the domestic country is a price-taker on the world market.

Figure 2.2

**Foreign trade with a new food safety regulation affecting only domestic producers**




tice protects domestic producers from foreign competition. Such practices are generally forbidden by World Trade Organization regulations, but enforcement of those regulations can be difficult.

## Trade Conflicts

Many different trade conflicts over food safety regulations occur every year. It is difficult to determine how many trade conflicts occur every year or how costly those conflicts are. However, in 1999, almost $400 billion worth of agricultural trade took place worldwide. Clearly, world food trade is not paralyzed by conflicts over food safety regulation. Some trade, however, could be inhibited by conflicts over regulations. Recent studies suggest that excessive technical barriers to trade, which include food safety regulations, might be responsible for measurable losses for agricultural exports from the U.S. (Henson and Caswell, 1999; Roberts and DeRemer, 1997). Other countries also experience losses.

Trade conflicts follow four common patterns. The first two stem from differences in preferences for food safety, and the second two stem from differences in the cost of providing food safety.

*(1) One country might use a process standard, while another uses a product standard, or each country might have different process standards.* While both product and process standards may result in a similar good or the use of similar production techniques, the fact that the requirements are different might result in one country's exclusion of another country's products, or even mutual product exclusion.

Alternatively, one country might require the use of one process, while another country requires the use of a different process. The U.S. and EU, for instance, have different mandated standards for their meat producers. The U.S. requires producers to adhere to HACCP plans, and the government inspects the final product (FSIS, 1998). The EU also uses HACCP plans, but has very specific practices that it requires its meat producers to use, including checking pig hearts for a specific type of disease and mandating that meat casings be purchased from EU-approved firms (Caswell and Hooker, 1996; FSIS, 2002). While these two approaches can result in meat of similar hygiene levels, the production methods differ. In the early 1990s, this caused a great deal of trade disruption, as the EU revoked the export certification of many U.S. meatpacking plants (USTR, 1996). The EU also bans the use of hormones for growth promoton in livestock production, while the U.S. allows the use of some (see chapter 4).

*(2) Countries might have different levels of safety standards.* Countries have different levels of tolerance for risk, and they might have different levels of willingness to pay for a reduction in their risk of consuming unsafe food. Thus, one country might have a pesticide residue or bacteria level standard that differs from those of its trading partners. For example, the EU has recently adopted a very stringent standard for aflatoxin on peanuts that could substantially reduce African peanut exports to the EU (Otsuki et al., 2001). Indeed, countries vary widely in the actual levels of aflatoxin allowed on foods (see chapter 6). Also, countries might differ in their perceptions of the level of risk, particularly when risks are unknown, which can also lead to differences in regulations.

*(3) Complying with a safety standard might be more difficult for foreign firms than for domestic.* Several types of regulations can be more difficult for foreign firms to comply with than for domestic firms. For example, the importing country may have a regulation that requires inspection or certification by a domestic agency. In such cases, it can be very difficult and costly for a foreign firm to determine what the regulations are, comply with them, and then obtain inspectors from the domestic agency.

Additionally, a foreign firm might have particular local conditions that make complying with safety standards very expensive or even impossible. An exporting country

might use pesticides that aren't used in the importing country, and are therefore not approved there. The presence of BSE in Europe, for example, and the difficulty of testing for BSE, makes it difficult for a livestock producer in the EU to convince foreign markets of the safety of his or her product.

The costs and logistics of complying with food safety regulations might be prohibitive for firms in some countries. In developing countries, specialized equipment, industrial engineers, and local government inspection might all be substantially more scarce and therefore more expensive to obtain. Therefore, poorer countries might have greater difficulty complying with food safety regulations imposed by their trading partners (Unnevehr, 2000).

*(4) A new safety problem might arise, or accidental contamination might take place.* Countries might agree in principle on food safety regulations, but one country might suddenly have difficulty in complying with those regulations. In 1998, when dioxin accidentally contaminated a large quantity of animal feed in Belgium, thereby contaminating animal products, the U.S. banned imports of animal products from Belgium temporarily (see chapter 8). In such cases, countries might agree on acceptable levels of food safety, but it has suddenly become prohibitively expensive or impossible for one country to meet the desired standard. Interruptions of trade are often temporary, as the exporting country works to correct the sudden change in food safety. Conflicts can arise if the importing country and the exporting country disagree on the conditions that must be met for products to return to acceptable levels of food safety.

## Consequences of Trade Conflicts

Countries can resolve their trade conflicts in a number of ways. The particular resolution chosen is often driven by the relative sizes of the costs of the regulations and the benefits of the trade flows. Three possible patterns of solving problems of differing standards include trade bans, adopting regulations of trading partners, or bilateral negotiation.

*(1) Cessation of trade / trade bans.* Some countries, unable to resolve their differences over food safety regulations, have simply ceased trading the product in question. This occurs if producers in the foreign country decide that the higher prices they can charge for the safer goods in the highly regulated market of their trading partner are not enough to meet the costs of complying with those regulations, and if the demanding country is willing to forgo cheaper imports in favor of the greater perceived food safety it receives from the highly regulated domestic good.

Trade might also cease for legal reasons if the domestic country imposes a trade ban. These bans might occur if, for instance, the gap between domestic and foreign regulations is simply too large to allow producers to satisfy both sets. For example, the EU refuses to accept U.S. chicken exports, treated with chlorine. The EU does not allow decontamination of poultry with chlorine while U.S. producers find it very difficult to meet stringent U.S. pathogen standards without the use of chlorine. A U.S. producer would find it difficult to comply with both sets of regulations. A country might also enact a legal trade ban when it feels that its trading partner cannot provide safe products at any reasonable price. For instance, the U.S. and many other countries have banned beef imports from Europe due to the presence of BSE.

When trade ceases, if the domestic country is not a major buyer of the good, then the foreign producers will sell their goods elsewhere. If, however, the domestic country is a major buyer, the demand for the foreign country's goods falls, reducing the price. In contrast, in the domestic country, reduced trade results in a reduction in the supply (domestically produced goods + imported goods) of the good, increasing the price. However, now consumers are presumably getting a safer good, as reflected by the new demand curve shown in figures 2.1, 2.3a, and 2.3b. If the foreign firm is really incapable of providing food of the desired safety level at an affordable price, then if the food safety gain is large enough compared with trade gains, trade should not take place. Additionally, if verification abroad or the risks of random safety crises prove to be too expensive for either the domestic or foreign party to willingly absorb, then trade might cease, because the domestic country is the lowest-cost producer of food safety and food safety information for that particular good.

In figure 2.3a, the domestic firm experiences the higher costs of providing the safe food. The increase in costs is even larger for the foreign firms, a fact that is reflected in the higher world price. The new higher world price, above the new domestic price, reflects the fact that other countries cannot supply the safer good at a price the domestic consumer is willing to pay. If the food safety gain is large enough, the domestic

Figure 2.3a

**A new food safety regulation applies to both domestic and imported goods, but foreign firms cannot comply**

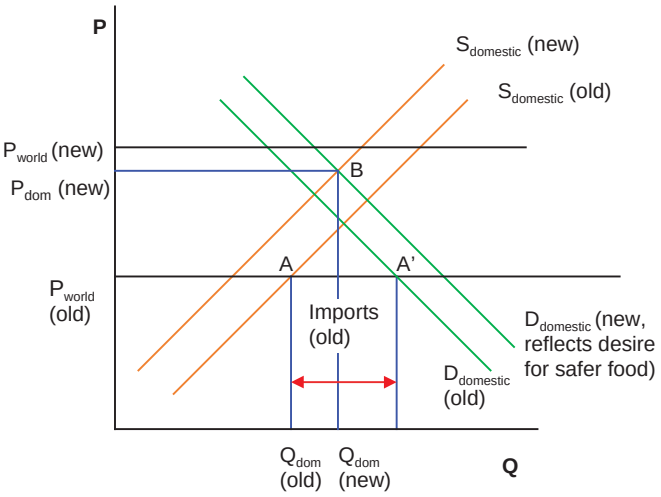
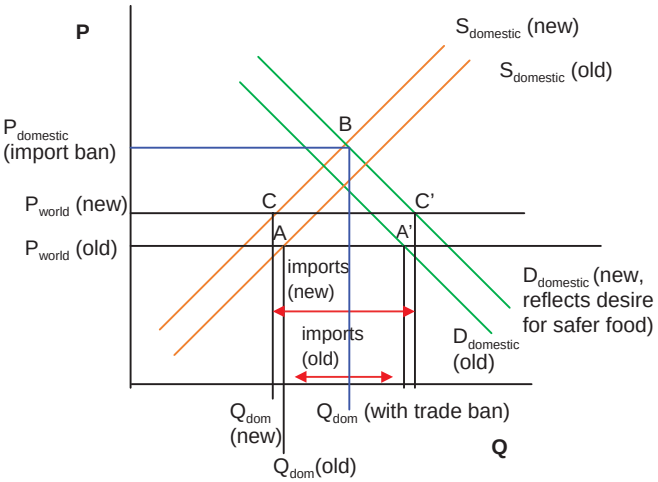



Figure 2.3b

**A new food safety regulation applies to both domestic and imported goods, and both foreign and domestic firms can comply**




country will move from equilibrium point A-A', with imports, to equilibrium point B, with no imports.

In the case of a strictly legal trade ban—i.e., the foreign supplier could provide satisfactory goods, but does not because the two countries simply have regulations that differ—consumers are missing the opportunity to purchase the imported goods. When the domestic government implements the new food safety regulations, again, both domestic and foreign firms experience an increase in production costs. In this case, however, while the safer imported goods (sold at the new world price) are more expensive than imported goods that do not implement safety regulations (sold at the old world price), the imports are still less expensive than the domestic goods. The new world price is below the domestic price. Before the new food safety regulations, the domestic market imported goods from the foreign country because such goods had characteristics the consumers wanted at a price they were willing to pay. If costs increase by similar amounts, for both foreign and domestic consumers, and if extra costs for foreign producers are not high, then trade may still be beneficial. If the transactions do not take place because of a trade ban, both domestic buyers and foreign sellers usually lose. In figure 2.3b, this would be akin to consumers paying the higher domestic price rather than the new world price available with trade. Domestic consumers and producers move from equilibrium point A-A' to equilibrium B, at a higher price and lower quantity consumed (but a higher quantity domestically produced). Consumers would be better off with trade in the new, safer good at equilibrium C-C', with more consumed (but less domestically produced) at the new world price than at point B.

Ceasing trade or trade bans can be quite costly, although the total cost depends on a number of factors. If trade ceases because the foreign country is unable to supply a good of the desired safety level, then the citizens of the home country have decided that the costs are worth the benefits. The foreign exporters lose revenue, but can frequently sell the goods elsewhere for a lower price. If, however, the trade conflict represents a dispute over differences in regulations, rather than the inability to provide a safe product, then domestic consumers lose as well as foreign producers.

Private domestic firms can lobby for restrictions that keep foreign products out of the domestic market. If the costs of this lobbying are less than the market share that the domestic firm gains by keeping the whole domestic market, a firm has some incentive to do this. This kind of lobbying can therefore be costly to the domestic country, but only if the lobbying results in keeping out goods that would satisfy consumers' needs for safe food at a lower cost.

In many cases, however, legal trade bans or cessation of trade might well be transitory, particularly if the food safety problem is temporary. In such cases, the costs of trade exceed the benefits in the short run, but if the foreign country is able to mitigate the food safety problem, trade once again becomes beneficial, and lifting the ban results in greater benefits than costs. For instance, after the Belgian dioxin crisis, trade between Belgium and its

partners resumed (see chapter 8). The U.S. detains some seafood imports if testing indicates that they are tainted (see chapter 7). While costly for the individual importer and exporter, such episodes do not necessarily result in long-term losses to consumers and producers.

*(2) Foreign firms comply with domestic regulations or adopt domestic standards.* Some countries will simply comply with or adopt the standards of their trading partners. This can occur when a country cannot negotiate a reduction in standards, when a country can meet the standards set by its trading partner, albeit at greater expense, and/or when the higher standards give some kind of marketing advantage. In this way, firms in the foreign country find that keeping their share in the importing country's market, perhaps with a premium, is worth the costs of complying with the regulations. Such costs include not only the increased costs of complying with the regulations, but also the information costs of finding out what the regulations are, which can be high if the regulations are complex and very different from the foreign firms' own domestic safety regime. Verification costs and the risk of random food safety crises must be added to the costs of compliance and weighed against the gains of receiving high prices for safe food in the domestic market. In figure 2.3b, the market moves from the equilibrium A-A' to C-C', where the increase in world prices reflects the increased costs of the food safety standards. Consumers here receive the benefit of having both foreign and domestic suppliers of the new, safer food, which allows them to pay a lower price than they would at equilibrium B, which represents sales of the new safer food but without any foreign suppliers.

Any two countries, of any income levels, who have divergent regulations can and have used this strategy. However, Baldwin (2002) suggests that the dynamics of adopting similar regulations can depend on the parties to a trade dispute. When industrialized nations, each with their own standards, experience a conflict, it is difficult to get one to adopt the other's standards, so protracted negotiations can follow, and eventually they may recognize the equivalency of each other's laws. Baldwin further notes when one country is a developing country and one is an industrialized country, their laws might be too divergent to allow mutual recognition. Thus, the developing country will sometimes conform to the industrialized nation's standard.

Countries can agree to comply with the standards of their trading partners only for the purposes of exporting, or they can agree to adopt their trading partners' standards. The latter process is called harmonization (Hooker, 1999). Harmonization can also refer to two countries adopting a third standard, discussed below.

One of the more positive spillovers of having to meet stringent foreign standards for exports is improvement in the safety and quality of domestic production (Donovan et al., 2001; Vogel, 1995). For instance, if a firm operating in a developing country has to purchase state-of-the-art equipment in order to produce for export to wealthier countries with higher safety standards, then the food produced for the domestic market could also become safer. If the new equipment represents a one-time expenditure, the price will probably not rise substantially, and the safer food might be affordable. However, the safer food might be more expensive if the costs of running the machinery are substantially higher. In such cases, the firm might sell cheaper food domestically, using the less expensive, less safe production process (Donovan et al., 2001).

*(3) Bilateral negotiation.* Compromises can occur when countries each perceive that losing trade will be more costly than altering its standards or regulations. Negotiations take place between governments, since individual firms usually (although not always) have limited influence on another country's regulations. If a compromise is desired, countries have a number of options from which to choose. Either or both parties can attempt to recognize the other's regulations, hammer out a compromise, or adopt or accept international standards or standards set by a third party (see chapter 3; Henson and Caswell, 1999; Sykes, 1999; Dolan and Humphrey, 2000; Holleran et al., 1999; and Hooker, 1999). Two countries agreeing to adopt a third standard is one form of harmonization. Recognizing each other's standards is often referred to as "mutual recognition," while gradually moving standards closer together is referred to as "coordination" (Hooker, 1999). These three types of policy action all require at least one country to alter its standards in some way, incurring costs in order to keep the benefits of trading internationally for food. In one prominent case, the U.S. and the EU have arrived at an agreement that has allowed them to resolve some of their problems with conflicting standards for the safety of meat products. U.S. firms wishing to export to the EU may obtain certification from the USDA, thereby avoiding the costly overseas inspection problem. The USDA, in turn, certifies that the firms are using EU-approved production processes in addition to meeting U.S. domestic standards.

Common or third-party standards include those set by the Codex Alimentarius. Some countries have adopted some of the Codex standards. International standards would ideally seem to reduce the costs of negotiations over a bilateral standard. Indeed, Casella (2001) theorizes that when a number of countries with divergent standards begin to trade, they can benefit from adopting common standards, since it reduces the costs of conforming to more than one set of standards. Yet, she also points out that countries are better off with two sets of standards rather than one, so that they can appeal more exactly to the tastes of different sets of consumers. With two sets, each set of standards can be chosen to appeal to the tastes of a different set of consumers, while one set of standards might be rather far from the tastes of each set of consumers. Additionally, agreement on any third standard may itself be difficult and costly. Baldwin (2002) notes that trying to negotiate a solution in which the two parties agree on a third standard that both will adopt is rarely successful.

Rather, some suggest that mutual recognition of each other's standards is preferable, citing the fact that the EU member states found it much easier to recognize each other's standards than to agree on new ones that all would adopt (Baldwin, 2002; Vogel, 1995). However, if two countries are experiencing trade conflicts because they find their trading partners' standards do not satisfy their desire for reduced risk, mutual recognition is not necessarily an easy solution either. Indeed, economists have begun to recognize that individual consumers often require more compensation to give up a good once they have it, than they were willing to pay for the good in the first place (Kahneman and Tversky, 1991). Thus, if a country perceives that it is giving up a level of food safety that it has achieved, then they may be unwilling to compromise, even if the less expensive food they can purchase from abroad would appear to compensate them amply for a small reduction in food safety.

Bilateral negotiation will occur when a highly regulated country does not wish to lose a lower cost supplier, or fears that its trading partner might retaliate against a stringent standard with stringent standards or tariffs of its own. The domestic country must perceive these benefits from trade to be greater than any reductions in food safety they might incur with a less stringent standard, increased costs of verification under the new standard, or increased costs resulting from their own producers' having to alter their production practices. In order to be willing to compromise, the foreign supplier usually must perceive that keeping their share of the home country's market is worth some potential increase in the cost of producing for the domestic country under the new regulations. Economic theory suggests that there are numerous possible solutions when two economic actors attempt to negotiate a contract. If the home country is an important buyer of the foreign country's products, then it is more likely to be able to exert influence and push for a supply of product closer to its own standard. If the foreign country is an important supplier of the good in question, then the foreign country will be able to exert influence in the negotiations, since it is likely that the costs of obtaining alternative supplies will be high for the home country.

## Conclusions

As advances in science and increases in wealth put greater focus on food attributes, both firms and governments find themselves increasingly responding to consumer demands for food safety. Firms have incentives to provide safe food, but in some cases, the market and legal incentives are insufficient to give consumers the level of protection that a society as a whole would like. In such cases, governments enact food safety regulations, and at some point, the regulations of trading partners are bound to conflict, as countries choose different types of regulations and different levels of stringency from the wide array of options available.

When conflicts occur, countries may stop trading in some items, one or both countries may alter their standards, or they may maintain both standards. The option countries choose should depend on the cost of implementing the strict standards compared with the price that consumers are willing to pay for safe food, and also on country differences in the costs of complying with the new standards. If firms find it too difficult and costly to satisfy the demand of consumers in the markets of their trading partners, they might forgo trade or try to lobby for a change in their trading partners' regulations or a compromise solution. If, however, firms can charge an adequate premium in the market with more stringent standards, they might adopt the standards of their trading partners, which can, under certain conditions, eventually improve food safety in the domestic market.

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*Chapter 3*

# Resolving Trade Disputes Arising from Trends in Food Safety Regulation

## The Role of the Multilateral Governance Framework

Donna Roberts and Laurian Unnevehr[1]

## Summary

This chapter examines current trends in food regulation, to see how they may influence international trade and to ascertain if, when, and how multilateral mechanisms can resolve trade conflicts. New approaches to food safety regulation that emerged in industrialized countries during the 1990s include:

- The growing use of risk analysis,
- Establishing public health as the primary goal of food safety regulation,
- Emphasizing a farm-to-table approach in addressing food safety hazards,
- Adopting the Hazard Analysis and Critical Control Point (HACCP) system as a basis for new regulation of microbial pathogens in food,
- Increasing the stringency of standards for many food safety hazards,
- Adding new and more extensive regulation to handle newly identified hazards, and
- Improving market performance in food safety through provision of information.

These regulatory trends have several implications for how food safety standards affect international trade in food products. Some new regulatory developments are likely to mitigate potential barriers to trade. For example, new kinds of regulation or public intervention that focus on voluntary provision of information (e.g., certification for certain kinds of production practices) can facilitate trade, even when standards and requirements differ among countries. Other trends, though, may impede trade. For example, if new or more stringent standards are in the form of process standards, (e.g., under HACCP systems), it can be difficult to determine if imported products are as safe as those produced domestically. Whether certain kinds of process requirements are necessary to achieve an equivalent risk outcome can be subject to dispute.

The 1995 Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), negotiated by World Trade Organization (WTO) members, recognizes the need for countries to adopt SPS regulations while establishing a framework to reduce their trade distorting aspects. Under these rules, WTO members reported 187 complaints related to food safety regulations from 1995 to 2001, which provides some evidence of the extent to which new food safety regulations have created barriers to trade.

Three of the principles under the SPS Agreement—science-based risk assessment, equivalence, and harmonization—directly address some aspects of food safety regulation that create the potential for trade disputes. Progress toward realization of these principles is reviewed here to see how well the SPS Agreement and supporting institutions have addressed emerging issues arising from regulatory trends. The agreement's requirements for the use of scientific risk assessment, for example, have led to the resolution of a number of disputes. Less progress can be reported in reducing transaction costs to trade through equivalence or harmonization. Multilateral institutions continue to work on projects—such as identifying the types of technical assistance that best help developing countries meet food safety requirements in key export markets—to achieve welfare-enhancing trade.

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## Introduction

New developments in food safety regulation, including new and more stringent standards for many hazards, occurred in many countries during the past decade. Both existing and emerging measures to protect human health can affect trade in agricultural products by increasing the costs of imports or prohibiting them entirely. The imposition of new performance standards (such as maximum residue levels for pesticides) or process standards (such as the required use of filters for irrigation water) may alter the cost of foreign supplies relative to domestic production. Requirements for certifying compliance with importers' standards may effectively prohibit imports from countries that lack adequate regulatory infrastructure, even if individual foreign firms can meet importers' standards. Such costs from reduced trade must be balanced against the public health benefits of safer food, and the market benefits of increased consumer confidence. It is the balance of such costs and benefits among countries that makes these measures so controversial in international trade.

During the last round of multilateral trade negotiations, exporters voiced concerns that sanitary and phytosanitary (SPS) measures to protect animal, plant, or human health were sometimes used to shield domestic industry from foreign competition, and that such protectionist pressures would increase as other trade barriers such as tariffs fell. The 1995 Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) was therefore negotiated by the WTO to provide a set of multilateral rules that would recognize the legitimate need for countries to adopt SPS regulations while establishing a framework to reduce their trade distorting aspects. To implement this agreement, the WTO relies in part on three multilateral standards organizations, and also draws on the expertise of other international scientific organizations. Together, these institutions, along with their principles, rules, standards, and enforcement mechanisms, comprise the multilateral governance framework for food safety regulation (Josling et al., forthcoming).

The impact of SPS measures on trade and welfare is largely unknown, primarily because we lack systematic information on the incidence of these measures themselves and because of underdeveloped methods of economic assessment (Beghin and Bureau, 2001; Maskus and Wilson, 2001; Roberts et al., 1999). However, there is substantial evidence that disagreements over SPS measures are becoming more important over time due to several trends. Reduction in traditional trade barriers, growth in trade of fresh and minimally processed foods, growth in trade of livestock products, and increased consumer awareness and demand for safety have all contributed to increased disagreements over SPS measures and allegations that they pose barriers to trade (Unnevehr, 2000; Henson and Loader, 1999; Dyck and Nelson, 2000; Buzby and Roberts, 1999).

Resolving trade conflicts over food safety regulation is viewed as possibly one of the biggest challenges facing the international trade system. It is widely recognized that a perceived failure to accommodate legitimate differences in food regulations could increase opposition to trade liberalization in general. Effective governance of the interface between food safety regulation and trade relies on the efforts of multilateral institutions and national regulatory authorities.

## Current Trends in the Regulatory Environment

Several changes in the global food system—increased scientific understanding of foodborne hazards, increased international trade in food products, and changes in how consumers obtain and prepare food—have brought renewed attention to food safety regulation in many countries. The science of public health is now better able to identify new foodborne pathogens and other hazards, estimate the incidence and severity of foodborne illness, and trace hazards to their sources. Increased public awareness of microbial pathogens has raised public concern about this type of foodborne hazard. In industrialized countries, consumers carry out less food preparation, consume more fresh and minimally processed foods, and consume more meat and seafood products. A greater share of consumption is now imported in many countries, including many fresh products. These changes in consumption patterns alter the sources and incidence of risk and reduce consumer control over food safety, at the very time that increasingly affluent consumers are demanding a higher level of safety.

Some well-publicized crises have brought these changes to the attention of the public. In 1993, an outbreak of *Escherichia coli* O157:H7, a new and more virulent strain of *E. coli*, was linked to consumption of undercooked hamburger contaminated with the bac-

terium. The outbreak caused over 700 illnesses and 4 deaths in several Western States. This pathogen drew further U.S. media attention later in the 1990s when outbreaks were associated with unpasteurized fruit juice and bagged salad lettuce. In 1996, bovine spongiform encephalopathy (BSE), or "mad cow" disease in cattle, was linked epidemiologically to the emergence of new variant Creutzfeldt-Jakob disease (vCJD) in humans who had consumed meat contaminated with the BSE causative agent. Consumers in the UK and elsewhere in Europe where BSE has been found in cattle were especially affected. And in 1999, supplies of several animal-derived foodstuffs produced in Belgium were contaminated with dioxins associated with animal feed prepared from tainted fats and oils. The resulting food recalls and disruptions in trade crippled the Belgian economy. These outbreaks or incidents have often resulted in new food safety regulation.

New approaches to food safety regulation emerged in industrialized countries during the 1990s following these changes in science, markets, and consumer awareness. The following discussion presents seven main trends in regulation worldwide:

(1) The growing use of risk analysis,

(2) Establishing public health as the primary goal of food safety regulation,

(3) Emphasizing a farm-to-table approach in addressing food safety hazards,

(4) Adopting the Hazard Analysis and Critical Control Point (HACCP) system to regulate microbial pathogens in food,

(5) Increasing the stringency of standards for many food safety hazards,

(6) Adding new and more extensive regulation to handle newly identified hazards, and,

(7) Improving market performance in food safety through provision of information.

*The new approach to food safety regulation is based upon risk analysis*, which includes risk assessment, risk communication, and risk management. Risk assessment is to be science-based, and includes identification of the sources and incidence of the risk, as well as identification of possible control strategies. The results of risk assessment must then be communicated, inviting public participation in the risk management process. Risk management entails choosing the appropriate level of protection and selecting suitable interventions or control options.

This approach to food safety regulation was recommended in reports by the National Research Council of the National Academy of Science (NRC, 1985; NRC, 1987) for U.S. food safety regulation, and is generally embraced by U.S. agencies. For example, FDA and USDA have recently carried out risk assessments for *S. enteritidis* in shell eggs, *E. coli* O157:H7 in hamburger, BSE in beef cattle, antibiotic-resistant *Campylobacter* in poultry, *Vibrio vulnificus* in shellfish, and *Listeria monocytogenes* in ready-to-eat meat products. These risk assessments have generally been undertaken to see whether new regulation is warranted. The 2002 European Food Law embraces this approach as well, as do all of the European food safety agencies in member states of the European Union. The Joint Institute for Food Safety and Applied Nutrition at the University of Maryland lists several publicly available food safety risk assessments carried out by government agencies in other countries, including Canada, Denmark, the Netherlands, and the United Kingdom (JIFSAN, 2002).

*The primary goal of food safety regulation is public health*. In the past, some food safety agencies have had multiple mandates relating to other issues such as food quality, industry promotion, or animal health. To more clearly focus food safety regulation on public health and consumer protection, several countries have reorganized their food safety regulatory agencies in order to refocus and to integrate previously scattered functions:

- Australia and New Zealand established the Australia and New Zealand Food Authority or ANZFA in 1991 to create uniform food regulation in both countries; in July 2002, the Food Standards Australia-New Zealand agency was established and charged with setting standards for primary products;
- Canada established the Canadian Food Inspection Agency in 1997 to unify inspection activities previously spread across several agencies;
- France established the Agence Francaise de Securite Sanitaire des Aliments (AFSSA) in 1999 to provide systemwide authority for risk assessment and intervention;
- The United Kingdom Food Standards Agency was created by an act of Parliament in 1999, and is set

up to be a quasi-independent watchdog to protect public health and consumer interests;

- Ireland created the Food Safety Authority in 1998;
- The European Union (EU) created a new Food Safety Authority in early 2002, following earlier reorganization of EU directorates in 1997 to address consumer protection in response to food safety concerns following the BSE crisis (Vos, 2000).

In the United States, FDA has always had public health protection as its sole mandate. However, 12 Federal agencies have some responsibility for food safety, and many have other public goals in addition to public health. To better focus food safety activities in the U.S., greater coordination among the various regulatory agencies has been established at the Federal level (President's Council on Food Safety, 2001).

Regulatory agencies increasingly recognize that *a farm-to-table approach is often desirable for addressing food safety hazards*. Many foodborne hazards can enter food at many points during the production process. Once present in food, some hazards can multiply or cross-contaminate other foods during transportation, processing, and preparation. Thus, control of foodborne hazards may involve interventions at many points in the food production and distribution system. Interventions at one level may influence control options at subsequent points in the supply chain from producer to consumer. Finally, there may be tradeoffs among controls at different levels in terms of the risk reduction achieved and the costs incurred. Thus, for many hazards, the ideal risk assessment examines the entire food production and distribution system.

The farm-to-table approach is clearly articulated in the new EU Food Law as a principle for future food safety regulation. However, the EU policy also recognizes that different kinds of regulatory measures may be needed at the farm level, due to the difficulties of controlling hazards in a farm environment. In the United States, the farm-to-table approach was used in developing new regulatory approaches to *S. enteritidis* in eggs (see box).

*Countries are increasingly adopting the Hazard Analysis and Critical Control Point (HACCP) system as a basis for new regulation, often of microbial pathogens in food*. HACCP requires identification of critical control points and development of procedures for monitoring controls and addressing any failures in control. Often, firms or industries are given some flexibility in determining control points and critical limits, so that implementation of HACCP is adaptable to many different contexts. The imposition of regulations mandating HACCP systems reflects a growing recognition that it is important to prevent and control hazards before they reach the consumer.

In 1996, the USDA's Pathogen Reduction/HACCP Regulation mandated the use of HACCP in meat and poultry slaughter and processing plants in order to reduce microbial pathogens (USDA, 1996). The FDA mandated HACCP for seafood plants in 1995 (FDA, 1995), and for fruit juice in 2001 (FDA, 2001). Canada also requires HACCP for fish, seafood, meat, and poultry plants. In the European Union, HACCP was mandated in 1993 for the entire food system, though it has been implemented in different ways within member countries.

## Box 3.1—Farm to Table Risk Assessment for *Salmonella enteritidis* in Eggs

The risk assessment of *Salmonella enteritidis* (SE) carried out by the FDA and the USDA's Food Safety and Inspection Service and Animal and Plant Health Inspection Service examined the interdependence among control options at different stages of processing and handling. It provided the basis for an action plan (President's Council on Food Safety, 1999). The risk assessment model indicated that multiple interventions would achieve more reductions in SE illness than would a single point of intervention.

The action plan identifies a set of activities at each stage of the production chain. Producers and packer/processors can choose between two strategies designed to give equivalent performance in terms of reduction in SE at the egg production and packer/processor stages. The first strategy focuses on farm-level testing and egg diversion; the second strategy directs more resources to the packer/processor level and includes a lethal treatment, or "kill step" (and HACCP plan) at this stage. Both strategies include regulatory presence on the farm (e.g., control of chicks from SE flocks) and at the packer/processor (e.g., washing, mandated prerequisite programs of sanitary controls). In addition to these interventions, the action plan sets refrigeration standards for the distribution and retail stages to ensure that reductions in SE are preserved at later stages in the food supply chain.

Over and above the general principles in the new regulatory approach, *there is also a trend toward more stringent standards for many food safety hazards*. HACCP regulations frequently consolidate existing codes of hygienic practice or sanitation standards with new requirements. For example, the 1996 Pathogen Reduction/HACCP Regulation for U.S. meat and poultry plants also required written sanitation procedures and pathogen tests to verify that HACCP is reducing hazards. These standards are in addition to previous sanitation requirements for plants. In the EU, earlier HACCP directives have been replaced by a new directive in 2000 that extends requirements for recordkeeping and corrective action.

Standards for other kinds of hazards have changed. The U.S. Food Quality Protection Act, passed in 1995, mandates that no harm result to infants and children from aggregate exposure to all pesticide residues. This has brought about a reassessment of all currently registered pesticides, beginning with the widely used class of chemicals called organophosphates. In the EU, new, unified standards were proposed for aflatoxins on crops in 1998. In unifying standards across member states, the new standards reduced allowable levels of residues in most countries. Comments on this change from EU trading partners led to some revisions in the unified standard that was implemented in 2001 (and modified in 2002).

In addition to more stringent food safety standards, *newly identified hazards have brought about new and more extensive regulation*. For example, BSE poses both animal and human health risks. Its mode of transmission among cattle or between animals and people is not fully understood. New regulations in the United Kingdom and elsewhere—regarding animal age at slaughter, monitoring of animal herds, testing of animal brains at slaughter, exclusion of specified risk materials (brain, spinal cord, eyes, tonsils, etc.) from meat products and meat cuts, and exclusion of mammal products from cattle feed—are designed to reduce the risk of transmission. These regulations are extensive, covering every step of the food production and distribution system from animal feed to meat butchering. They also have had an impact on a wide range of byproducts, including gelatin used in pharmaceuticals.

Another example of newly identified hazards is the growing awareness of potential transmission of antibiotic resistance from food animals to humans. This has led to new regulations regarding the nontherapeutic use of antibiotics in food animals, most notably in the EU, where such uses are banned entirely. In the U.S., such uses are under review, and the FDA has issued new guidelines for assessing the risk of resistance to antibiotics used in feeds.

Other new approaches to food safety regulation attempt to *improve market performance through provision of food safety information*. These approaches include the use of voluntary guidelines or standards, provision of third-party certification, provision of information through labeling, establishing legal liability for food safety, and establishing voluntary or mandatory systems for traceability (table 3.1). Such interventions may improve performance by providing information or incentives that encourage consumers to choose safe food and reward producers for its provision. The public role in these new approaches, and the degree to which they are mandatory or voluntary, varies among countries.

## Unresolved Public Policy Issues

These new trends in food safety regulation have come about mostly over the past decade. As these trends are still evolving in many countries, three public policy issues remain unresolved. First, the role of scientific and economic analysis in risk management varies widely among countries. In the United States, regulations must be science-based. Economic analysis is mandated for major regulations with an estimated economic impact over $100 million and for all food safety regulation within USDA (Executive Office of the President, 1993). Economic analysis played a role in the design of the Pathogen Reduction/HACCP Regulation, as analysis of the fixed cost implications led to staggered implementation dates for plants of different sizes. In the European Union, risk management decisions may include “other legitimate factors” that extend beyond scientific and economic analysis (Henson, 2001). Such factors include consumer concerns, the environment, animal welfare, and other political or economic factors, such as the impact on small farms. In Australia and New Zealand, cost-benefit analysis with risk assessment is extensively used. For example, in the 1998 redesign of food safety regulation, the regulatory approach that was chosen balanced expected benefits to consumers and industry against the costs of regulation to industry and government. Such analysis in Australia, Canada, and New

**Table 3.1—Information-based approaches to food safety interventions**

| Approach | Example | Public sector role | Food safety benefit |
|---|---|---|---|
| Guidelines | UK voluntary guidelines for farms to reduce *Salmonella* in pigs<br>U.S. voluntary Good Agricultural Practices to reduce microbial hazards in fresh fruits and vegetables | Public sector can develop guidelines or certification that is science-based, directed toward public health, and credible to consumers | Reduces hazards, but only where guidelines or certification adopted; and reduce transaction cost in markets for safety. |
| Third-party certification | USDA Quality Through Verification program certifies that fresh produce is produced under HACCP<br>Netherlands IKB programs for livestock producers | | |
| Labeling | U.S. required safe handling labels on fresh meat and poultry products<br>EU novel food regulation requires labeling of novel foods | Identify where information critical to facilitate consumer choice; respond to consumer demand for information | Reduces market failure where information previously lacking; alters hazard incidence in some cases |
| Liability | UK 1990 Food Safety Act | Establishes responsibility for food safety | Improves safety by providing incentives for producers to follow practices that minimize hazards |
| Traceability | EU Food Law establishes as principle for food safety policy<br>Japan requires traceability in beef sector | Establish information and marketing channel requirements | Facilitates tracing problems in case of outbreak; can provide incentives for producers to improve safety |

Zealand pays particular attention to international markets and the impact of new regulations on trade as an important economic dimension.

Second, controversy surrounds the role of standards. In the United States, a recent court decision declared that USDA could not shut down a meat grinding plant for failing to pass a performance standard based on *Salmonella* incidence. The USDA is currently reviewing the role of microbiological performance standards, and it is not yet clear what role these may play in addition to sanitation process standards. In the EU, the mandate for HACCP in all parts of the food production and distribution system is not always practical for small retail establishments, so in many cases regulation instead relies on codes of hygienic practice (Jansen, 2001). These more prescriptive process standards do not really follow the HACCP model of prevention and control.

The role of process and performance standards in regulating different kinds of hazards is changing. Inputs that are added during the production process are often subject to performance standards, such as tolerances for pesticide residues. However, some inputs are subject to process standards such as withdrawal times for antibiotics in animals or required recordkeeping for use of growth hormones. It is more difficult to set performance standards for microbial hazards, as they can enter the food supply at many points during production and distribution, and can grow or cross-contaminate other foods. Regulation of microbial hazards has often meant setting process standards, such as standard sanitation procedures or codes of hygienic practice. Microbial hazards may be more frequently subject to performance standards in the future, as the need to verify HACCP systems is recognized and new tests are developed that provide more timely and specific results.

A third unresolved issue is regulatory agency capacity and authority. In many cases, existing regulations require review or removal in order to implement new kinds of regulation. This kind of review took place in Canada, the United States, and the United Kingdom to reduce regulatory burden and to ensure consistency in how regulations are applied. Another issue is whether existing regulatory authority extends throughout the food system. When it does not, then certain kinds of intervention may not be possible. The EU Food Law establishes regulatory authority for the entire food production/distribution system, but such authority does not exist to the same extent in the United States. USDA's Food Safety and Inspection Service does not have authority to regulate at the farm level. In some cases, FDA or the USDA's Animal and Plant Health

Inspection Service may regulate food safety at the farm level, but this is not the focus of either agency.

## What Are the Implications for International Food Trade?

Regulatory trends, associated unresolved public policy issues, and the growth in world food trade have several implications for how food safety standards affect international trade in food products. First, *the simultaneous move toward improved safety among industrialized countries creates the potential for convergence around higher standards*. That is, as developed countries with major markets adopt new regulations, there is incentive for other countries to follow suit (Vogel, 1995). New regulations are undertaken in some countries in response to other countries' actions. This rationale has been explicitly mentioned in regulatory impact analysis in Australia and Canada, for example. USDA's survey of 35 countries that export meat and poultry to the United States also attests to the demonstration effect of stringent food safety standards in importing countries (*World Food Chemical News*, 2000). More than a third of the 29 respondents to the survey indicated that they had adopted HACCP in all (not just exporting) establishments, while nearly half had adopted HACCP for at least some of their nonexporting establishments. Such convergence likely reduces the potential for trade disputes.

*New kinds of regulation or public intervention that focus on provision of voluntary information, such as certification for certain kinds of production practices, can facilitate trade, even when standards and requirements differ among countries*. The FDA developed guidelines for minimizing microbial hazards, so-called Good Agricultural Practices (GAPs) (FDA, 1998). While not mandatory for market access, these guidelines provide a basis for exporters to privately certify food safety to produce wholesalers in the U.S. (see chapter 5). In another example, a USDA certification program for meat producers enables U.S. firms to export to the EU if they voluntarily apply to USDA for certification that they meet EU requirements (which are different from U.S. regulations). A USDA certificate then accompanies export shipments.

Although some new regulatory developments might mitigate potential barriers to trade, *the appearance of new hazards, or increased trade volumes from new sources, can lead to food safety incidents or disputes in trade*. A disease outbreak or newly identified hazard often leads to disruptions in trade and may strain relations with trading partners. In the Belgium dioxin crisis, the Belgian government was criticized for not providing timely information to other countries that imported implicated products. The BSE discoveries in the United Kingdom disrupted trade between that country and other members of the EU. In the United States, the first food-related outbreak from *Cyclospora* in the United States led to an import ban on Guatemalan raspberries (see chapter 5).

The imposition of new, higher standards—as well as remaining differences among countries in how standards are developed and applied—can also lead to trade disputes. In particular, *rising standards and the rapid change in food safety regulation in the industrialized countries creates challenges for developing countries*, many of which have seen rapid growth in food exports since the 1990s (Unnevehr, 2000; Henson and Loader, 1999). For example, the proposed new standards for aflatoxin in the EU had a disproportionate impact on exports from developing countries (Otsuki et al., 2001). These countries may lack infrastructure to ensure basic sanitation in processing and transport, as well as public oversight to certify certain kinds of safety. The issue of equivalence in safety outcomes has been identified by developing countries as important in implementation of the SPS Agreement.

*New or more stringent process standards entail greater difficulties in determining whether an equivalent safety outcome has been achieved*. While HACCP may be widely accepted as an approach to food safety, specific HACCP regulations for specific food sectors may result in different outcomes. As required HACCP systems may or may not be linked to specific performance standards, it can be difficult to determine if imported products are as safe as those produced domestically (Hathaway, 1995). Other kinds of process controls, such as recordkeeping or traceability requirements,[2] can impose objectionable costs on trading partners. Whether such requirements are necessary to achieve an equivalent risk outcomes can be a matter of dispute. For example, the United States is concerned that new EU regulations regarding control of feeds to prevent BSE could impose unreasonable costs on the U.S. feed industry, given that the EU's own risk assessment indi-

[2] Traceability requirements are recordkeeping systems used to help keep foods with different attributes separate from others (Golan et al., 2002)

cates that the probability of BSE appearing in the United States is negligible (Schwartz, 2001).

*Strong differences remain with respect to consumer risk preferences, consumer perceptions, and the role of nonscience issues in regulatory decisionmaking*. Both consumer risk preferences and consumer perceptions are at issue in the longstanding disagreement between the U.S. and the EU over use of growth hormones in beef (see chapter 4). Nonscience issues such as the preservation of small farms are a consideration in EU decisions about inputs like growth hormones or r-BST (recombinant bovine somatotropin, a synthetically produced version of a naturally occurring hormone intended to increase milk production). Differences in perception and willingness to assume unknown risks are evident in more recent disagreements over the acceptability of genetically modified organisms (GMOs) and labeling of foods produced through modern biotechnology. Furthermore, nonscience issues such as ethical concerns about genetic modification are at play in the dispute over modern biotechnology. Food safety issues may be difficult to separate from other contentious issues in cases like these.

In summary, changes in regulatory approach may lead to some convergence in food safety standards, but the dynamic nature of food trade, the onset of new hazards, and differences in regulatory approach and capacity still instigate disputes and disruptions to trade.

## Disruptions to Trade From Food Safety Regulation: Evidence From the WTO

The SPS Agreement was established under the WTO in 1995, as a result of the 1986-93 Uruguay Round of Multilateral Trade Negotiations. This Agreement provides a framework for determining the legitimacy of SPS measures that restrict trade and for resolving potential trade conflicts. Its requirement for regulatory transparency, key to enabling judgment about the purpose or design of a measure, is achieved by "notifications" (to the WTO) of proposed changes in regulations that could affect trade. Trading partners are then entitled to comment on the proposed changes. If differences cannot be resolved in bilateral discussions, countries can raise the matter in the WTO SPS Committee. These complaints provide some evidence of the extent to which new food safety regulations have created barriers to trade.

### Complaints Raised in the WTO's SPS Committee

WTO members submitted more than 2,400 SPS notifications to the WTO between 1995 and 2001. Each notification indicates, among other things, what the proposed measure is, which product or products it is applied to, if it is based on an international standard, and when it is expected to come into force. These notifications provide an opportunity for trading partners to raise questions or objections to proposed measures in the SPS Committee before they are adopted as regulations. WTO members have taken advantage of this notification process, registering 187 complaints (or counter notifications) in the SPS Committee between 1995 and 2001 (table 3.2).[3] More than half (108) were related to human health measures (i.e., food and feed regulations). Developed countries were most often the source (68 percent) as well as the target (67 percent) of counter notifications that identified food and feed regulations as unjustified trade impediments. Both developed and developing countries cited the measures of developed countries in the majority of counter notifications related to human health. The complaints by developed countries (42) outnumbered those by developing countries (30) in this category, suggesting that access to the same scientific information and technologies still leaves ample scope for disagreement over food safety measures.

An examination of the counter notifications by commodity and hazard provides some insight into the sources of current tensions over regulations in international agricultural markets. Most notable are the number of counter notifications related to the regulation of transmissible spongiform encephalopathies (TSEs), which include BSE. TSE measures alone accounted for nearly half of the counter notifications related to food safety regulations since 1995, indicating the significant disruption to international trade caused by the BSE outbreak (table 3.3). This impact is related to the fact that cattle, the source of BSE, provide so many food and industrial products, including meat and milk for human consumption, gelatin for pharmaceutical purposes,

[3] Other WTO committees have formally adopted the term "counter notifications" to reference complaints recorded in the minutes or reports of committee meetings. The SPS Committee has not done so. Complaints are variously recorded under "information from members," "specific trade concerns," and "other business" in the committee minutes. The term *counter notification* is used here to help distinguish the complaints raised in the SPS Committee from the complaints that proceed to formal dispute settlement in the WTO.

**Table 3.2—Complaints (counter notifications) in the SPS Committee against trade partners, 1995 - 2001[1]**

| Respondents: | Complaints by developed countries | | | | Complaints by developing countries | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Human health | Plant and animal health | Other[2] | Subtotal | Human health | Plant and animal health | Other | Subtotal | |
| Developed country | 42 | 15 | 1 | 58 | 30 | 23 | 1 | 54 | 112 |
| Developing country | 31 | 18 | 1 | 50 | 5 | 16 | 1 | 22 | 72 |
| Multiple countries | -- | 1 | -- | 1 | -- | 2 | -- | 2 | 3 |
| Total complaints | 73 | 34 | 2 | 109 | 35 | 41 | 2 | 78 | 187 |

[1] Entries exclude “repeat interventions” made by WTO members who registered complaints against the same measure more than once.
[2] Includes complaints about administrative issues and horizontal regulations that address multiple health objectives.

Source: WTO Summaries of the Meetings of the Committee on Sanitary and Phytosanitary Measures, G/SPS/R series, 1995-01 and authors' calculations.

**Table 3.3—Distribution of complaints (counter notifications) related to human health measures in the SPS Committee, 1995 - 2001[1]**

| Commodity | Complaints against measures regulating: | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | TSEs[2] | Food additives | Foodborne pathogens | Toxins and heavy metals | Veterinary residues | Pesticide residues | Other[3] | |
| Multiple animal products | 44 | -- | -- | 8 | -- | -- | -- | 52 |
| Meat and meat products | 4 | -- | 8 | 2 | 2 | -- | -- | 16 |
| Multiple agricultural products | -- | 1 | -- | 13 | -- | -- | 2 | 16 |
| Dairy/Eggs | -- | -- | 6 | 1 | -- | -- | 2 | 9 |
| Processed products | -- | -- | -- | 5 | -- | 1 | 3 | 9 |
| Feedstuffs | 2 | -- | -- | 1 | 2 | -- | -- | 5 |
| Horticultural products | -- | -- | -- | -- | -- | 1 | -- | 1 |
| Cereals | -- | -- | -- | -- | -- | -- | -- | 0 |
| Total | 50 | 1 | 14 | 30 | 4 | 2 | 7 | 108 |

[1] Entries exclude “repeat interventions” made by WTO Members who registered complaints against the same measure more than once.
[2] transmissible spongiform encephalopathies (TSEs) include bovine spongiform encephalopathy (BSE).
[3] Complaints related to measures that regulated multiple hazards or genetically modified products, or had unknown objectives.

Source: WTO Summaries of the Meetings of the Committee on Sanitary and Phytosanitary Measures, G/SPS/R series, 1995-01 and authors' calculations.

semen for breeding, and other byproducts used in cosmetics, commercial animal feed, and elsewhere. The EU and Switzerland together registered more than half of these complaints, which were often directed at the initial emergency measures adopted by countries in 1996. The EU itself later became the target of 10 complaints following implementation of its new, extensive BSE regulations. Examples include Chile and Peru’s complaints against the EU’s ban on the use of fish meal in ruminant feed, and Australia’s complaint against EU restrictions on selected cosmetics.

The discovery of elevated levels of dioxin in Belgian animal feedstuffs also led to immediate restrictions on exports of a wide array of European animal products in 1999 (see chapter 8). The EU subsequently raised objections to the emergency dioxin measures of nine of its trading partners who, in the view of EU officials, maintained restrictions on animal products when these actions were no longer justified.

The fact that more counter notifications (82) were related to the regulation of animal products than any other product category is not surprising in view of the significant impact of the BSE and dioxin events.[4] The number of counter notifications (14) related to pathogen

[4] This total reflects counter notifications related to restrictions in the following categories: multiple animal products (52), meat and meat products (16), dairy and eggs (9), and feedstuffs (5).

control measures for meat, dairy, and eggs was also a factor in the number of complaints against measures regulating animal products. The regulation of other products drew far fewer complaints. Together, the number of counter notifications related to regulations applied to "multiple agricultural products" (16), processed products (9), horticultural products (1), and cereals (0) accounted for fewer than one-fourth of the total counter notifications related to human health measures.

The WTO Secretariat has aggregated the 108 separate food safety-related counter notifications into 40 issues or "special trade concerns." The Secretariat reports resolution or partial resolution in 16 of these cases (WTO, 2001a).

## Has Multilateral Oversight Helped Resolve Trade Disputes?

The framework that governs the interface of trade and food safety regulation includes the SPS Agreement and the multilateral organizations that are charged by the WTO to further implementation of the agreement. The SPS Agreement rests on two premises: that basing domestic standards on international norms will reduce conflicts and lower transaction costs, and that requiring scientific justification for standards that deviate from these international norms makes it more difficult for countries to shelter domestic industries behind unnecessarily restrictive SPS regulations. The role of international standards and the work of scientific organizations are therefore critical to the WTO's objectives of averting trade disputes and increasing welfare-enhancing trade.

### Provisions of the SPS Agreement

Prior to 1995, rules for SPS measures in the 1947 General Agreement on Tariffs and Trade (GATT) had allowed measures that were "necessary to protect human, animal or plant life and health" but stipulated that measures should not constitute disguised restrictions or create unnecessary trade barriers. The WTO SPS Agreement reiterates earlier commitments under the GATT, but also requires regulators to: (1) base measures on a scientific risk assessment (*science-based risk management*); (2) recognize that different measures can achieve equivalent safety outcomes (*equivalence*); and (3) allow imports from distinct regions in an exporting country when presented with evidence of the absence or low incidence of pests or diseases (*regionalization*).[5] Adoption of international standards (*harmonization*) is encouraged, but not required (see box).

In addition to setting out the rights and obligations of WTO members, the SPS Agreement also establishes enforcement mechanisms. These mechanisms include the notification procedures and the establishment of an SPS Committee to discuss these issues on a continuing basis. WTO dispute resolution mechanisms for resolving conflicts between countries in a timely manner are also available. These mechanisms include formal consultations between the parties to a dispute, followed by adjudication by a WTO panel and the WTO Appellate Body if required.

### Institutions in the Multilateral Governance Framework

Other intergovernmental organizations besides the WTO itself contribute to the implementation of the SPS Agreement by creating international standards or advancing scientific understanding of foodborne risks and their mitigation. The SPS Agreement identifies three organizations to promote harmonization through adoption of international standards: the Codex Alimentarius Commission (Codex) for human health measures; the International Office of Epizootics (OIE) for animal and human health measures; and the International Plant Protection Convention (IPPC) for plant health measures. Firms and governments have relied on the standards of these organizations—sometimes referred to as the "three sisters"—to facilitate the international exchange of agricultural goods for several decades, but their role has become more prominent since the SPS Agreement. The agreement does not require countries to adopt international standards, but those that do so are presumed to be in compliance with their WTO obligations.

While the SPS Agreement itself does not reference any other institutions, the SPS Committee also draws on the expertise of official observer organizations. The World Health Organization (WHO) and the Food and Agriculture Organization (FAO), which are well positioned to convene expert scientific panels on issues of emerging importance and to distribute their findings, are

[5] Regionalization is more germane to the regulation of plant and animal health than food safety.

## Box 3.2—Principal Provisions of the WTO's Agreement on the Application of Sanitary and Phytosanitary Measures

***The SPS Agreement requires:***

- Science-based risk management (*Articles 2 and 5*): SPS measures must be based upon scientific principles and sufficient scientific evidence; more particularly, measures must be based on a risk assessment. Measures should be chosen so as to minimize distortions to trade and must be no more trade restrictive than necessary to achieve a country's "appropriate level of protection." Members are to avoid variation in the levels of health protection provided by its measures if this variation creates a disguised restriction on trade. Countries may adopt a provisional measure to avoid risk, but must seek information and carry out a risk assessment to justify permanent use of a trade-restricting measure.
- Equivalence (*Article 4*): A WTO member must accept that the SPS measures of another country are equivalent to its own if it is objectively demonstrated that the exporter's measures achieve the importer's appropriate level of protection, even if the measures themselves differ.
- Regionalization (*Article 6*): A country is required to allow imports from regions that are free or nearly free of pests or diseases.[1]

***These obligations are balanced by a recognition of:***

- National sovereignty (*Article 3*): A country may choose a measure that differs from the international standard to achieve its appropriate level of protection as long as it complies with the other rules of the Agreement. This recognizes that individual nations may be unwilling to subscribe to uniform measures for all hazards.

***The Agreement endorses:***

- Harmonization (*Article 3*): Members are urged (but not required) to adopt international standards. A country that does adopt the standards of the three designated international organizations is presumed to be in compliance with its WTO obligations.

***The Agreement also establishes enforcement mechanisms, including:***

- Notification: A WTO member is required to publish its regulations and provide a mechanism for answering questions from trading partners.
- WTO SPS Committee: The WTO Committee meets three to four times a year to develop guidelines and discuss contentious SPS measures on a continuing basis.
- Dispute settlement: Mechanisms include formal consultations between the parties to a dispute, followed by adjudication by a WTO panel if required. Decisions by trade dispute panels may be appealed to the WTO Appellate Body.

[1] This provision is more germane to the regulation of plant or animal hazards.

among the most influential observer organizations. Their work on BSE, biotechnology, and other issues has been key to the resolution of some conflicts, particularly those arising over emergency measures adopted by countries in response to newly identified hazards.

## Implementation of the SPS Agreement

Three of the principles under the SPS Agreement—science-based risk management, equivalence, and harmonization—directly address some aspects of food safety regulation that create the potential for trade disputes.

### Science-Based Risk Management

The obligation to base regulations on scientific risk assessment clearly reduces the latitude for disingenuous use of SPS regulatory interventions. In each of the three SPS disputes[6] to reach the WTO Appellate Body since 1995, the regulations at issue were judged to violate this requirement.

[6] The three cases were EU—Hormones (brought by the U.S. and Canada); Australia—Salmon (brought by Canada); and Japan—Varietal Testing (brought by the U.S.).

However, the impact of the risk management requirements extends far beyond formal dispute settlement. The clear obligation to base measures on science has led to the resolution of many issues before they advance to dispute settlement. In particular, food safety measures that discriminate among sources of supply attract close scrutiny, and sometimes are seen to lack scientific rationale. For example, an exemption to a ban on sauces containing benzoic acid that Australia had granted to New Zealand during their transition to a common food standards system was replaced with a tolerance level for all imports following a Philippine complaint in the SPS Committee. Similarly, Spain modified its regulatory regime for cadmium and copper residues in squid that held imports to higher standards than EU products in response to a U.S. complaint.

Disagreements over less overtly discriminatory measures have been resolved by means of updated risk assessments. For example, Australia rescinded its 1994 ban on three kinds of raw milk cheeses from Switzerland following completion of its 1999 risk assessment that indicated that Swiss processing protocols attained at least the same level of pathogen destruction as pasteurization in hard cheeses (though not for semi-hard or soft cheeses). Further study similarly led Korea to amend its new Food Code to exempt poultry meat destined for further processing and cooking from its zero tolerance standard for *Listeria*, thereby allowing imports of Thai frozen chicken to resume (WTO, 2002a).

While the obligation to base measures on risk assessments can often avert trade disputes, it cannot do so in all cases. Relevant risk assessments may not be available to inform regulatory responses to new hazards. Emergency measures have only accounted for 17 percent of the total SPS measures notified to the WTO, but because such measures are generally very trade restrictive, they often give rise to complaints if importers fail to modify policies as new evidence emerges. For example, many countries suspended imports of European dairy products immediately following the March 1996 announcement of a possible link between BSE and its human variant, vCJD. Most countries rescinded these bans when the OIE and the WHO reaffirmed that existing scientific data did not indicate that these products are BSE vectors. However, the EU had to repeatedly petition Argentine regulators before they modified restrictions on dairy products—including Belgian chocolate, German milk powder, and Swedish cacao oil butter—in 2001.

Risk assessments also do not avert disagreements over measures that reflect extremely conservative approaches to mitigating scientifically verified risks. For example, 11 countries (supported by 11 others) objected to the EU's proposed regulation to lower tolerances for aflatoxin, a naturally occurring carcinogenic class of chemicals, in a wide range of foodstuffs in March 1998 (WTO, 1998a). The new tolerances were to be enforced by new sampling procedures that exporters also regarded as onerous. The World Bank estimated that the new regime for cereals, dried and preserved fruits, and edible nuts would result in an annual export loss of $650 million for nine African countries while achieving 1.4 fewer deaths per billion inhabitants than Codex standards (Otsuki et al., 2001).

The SPS Agreement protects a country's right to choose its "appropriate level of protection," stating only that when choosing these levels, members should (not "shall" which indicates a legal obligation) "take into account the objective of minimizing negative trade effects." The U.S. Statement of Administrative Action to Congress states that this provision, along with other language in the Agreement, "explicitly affirms the rights of each government to choose its levels of protection including a 'zero risk' level if it so chooses" (President of the United States, 1994). The national sovereignty principle reflected in the risk management provisions of the Agreement thus provides leeway for a country to adopt measures that achieve incremental risk reductions regardless of the cost (for its trading partners or its domestic consumers). These provisions were necessary to secure the support of developed countries during the negotiations, but by allowing policies that vary significantly from the norm they widen the scope for trade disputes, even among developed countries themselves.

The requirement to use the least trade restrictive means to achieve the appropriate level of protection did contribute to the resolution of many of the complaints related to the EU's proposed aflatoxin regime. The EU eventually decided to adopt the international standard for aflatoxin in groundnuts (15 parts per billion (ppb)) in lieu of the 10 ppb level it had originally proposed, agreeing with exporters that further processing (for confectionary products) or sorting (for direct human consumption) would lower residues to 10 ppb in final products. The EU also adopted a less costly, but equally rigorous sampling procedure to enforce its new standards (WTO, 1998b). However, not all complaints were resolved: developing countries, particu-

larly Bolivia and Argentina, continue to raise objections to some of the aflatoxin tolerances that were not revised (WTO, 2002a).

Other considerations besides scientific evidence and risk aversion sometimes factor into risk management decisions, leading to divergent policies that restrict trade. For example, recent developments in the regulation of food irradiation illustrate how other factors can lead to dissimilar policy choices despite a strong international consensus about the risks and benefits of this technology. The FAO, the International Atomic Energy Agency (IAEA), and the WHO concluded in 1980 (and in several followup studies) that the irradiation of any food up to a specified dose is safe and does not alter the nutritional content of food. In fact, the WHO encourages the use of irradiation in order to reduce the incidence of foodborne diseases caused by microorganisms (European Communities, 2001). The United States has long approved the use of irradiation for spices, and has more recently approved its use for a number of other food products, including meats and meat products, fruits and vegetables, and juices. However, other developed countries have been more reluctant to allow the use of this technology. European, Canadian, and Australian regulators currently allow dried herbs, spices, and other minor products to be irradiated, but have encountered resistance to permitting irradiation of other products from consumer and domestic industry representatives.

In fact, EU authorities have been considering irradiation regulations for more than 10 years. Despite the repeated recommendations of the EU's Scientific Committee on Food to allow the irradiation of products such as fish, fresh meats, poultry, produce, and raw milk cheeses, consumer concerns about the safety of this technology and related questions about the "technological need" for this form of pathogen control persist (European Communities, 2001). Current EU Commission proposals for a list of products that may be irradiated have drawn criticism from the United States in the SPS Committee as the list includes only a few products such as frogs' legs, peeled shrimp, herbs, spices, and seasonings (WTO, 1998c).

While countries' increasing reliance on scientific risk analysis to inform food safety policies has led to a convergence of standards, a number of gaps remain. This is true even among trading partners who are at the forefront of this trend, as the WTO counter notifications indicate. For some of these complaints, the SPS Agreement's requirements to base measures on scientific risk assessments and to use the least trade restrictive means for achieving public health goals have led to the quick resolution of trade conflicts, particularly those involving transparently discriminatory measures. The Agreement's science requirements have also prodded authorities to revisit regulations whose longevity could be attributed to simple inertia rather than overt protectionism. The SPS Agreement provides no further elaboration of risk management principles, other than the recommendation to minimize trade effects when choosing levels of risk reduction. The countries that negotiated the SPS Agreement judged that it was inappropriate for the WTO to be more prescriptive about risk management, seeing Codex as the better forum for the development of best regulatory practices related to food safety.

Some guidance has been provided by Codex[7] but, as yet, there is still disagreement over the role of precaution and "other legitimate factors" in Codex debates as well as in regulatory policy (as in the aflatoxin and irradiation cases) (Codex Alimentarius Commission, 2001). Eventual agreement on risk management principles in Codex may further narrow the scope for trade disagreements, but these principles are unlikely to eliminate disputes over the question of the best course of action to take, given the scientific evidence. Science is descriptive, not prescriptive; a risk management decision will therefore always require a choice among different policy options, each with different costs and benefits. Options that severely limit market access to achieve extremely incremental health benefits are likely to be contentious, even if based on science.

### *Equivalence*

Article 4 of the SPS Agreement requires members to accept other countries' measures as equivalent to their own if an exporter can demonstrate that its measures achieve the importer's desired level of SPS protection. This provision recognizes that regulatory flexibility allows countries to allocate scarce resources efficiently rather than identically. The Agreement also promotes trade based on equivalence of SPS measures by requiring members to enter into consultations for bilateral

[7] Two of the most important Codex documents providing risk management guidance are the "Statements of Principle on the Role of Science in the Codex Decision-making Process and the Extent to which Other Factors are Taken into Account" (or "General Principles") and the "Working Principles for Risk Analysis."

and multilateral equivalence agreements upon request by the exporter.

Equivalence determinations usually involve process standards, since countries are better able to compare performance standards, which stipulate observable and/or testable attributes of end products. An enormous number—and arguably a growing proportion—of SPS measures are process standards. The equivalence obligation therefore has the potential to yield significant benefits in international markets for products such as cheeses, meats, fresh produce, and seafood for which process standards are key to managing microbial risks.

Although the SPS Committee has urged members to submit information on their bilateral equivalence arrangements, few have done so (WTO, 2001b). Consequently there is no systematic accounting of achievements to date.[8] However, the use of equivalence is still rare in international food trade (Gascoine, 1999.) The United States and the EU did sign a framework agreement for recognizing equivalence of some SPS measures for selected animal products in July 1999, after 6 years of occasionally high-profile negotiations over matters as minute as the colors of wall paint in food-processing facilities. This framework agreement applies to $1 billion in EU exports of dairy products, fish, and meat to the United States, and $1 billion in U.S. exports of fish, hides, and pet food to Western Europe. The exporting country must still comply with the importing country's measures that are not included in the framework agreement, including those regulating food and feed additives and animal drug residues. Both the EU and the United States also recognize the equivalence of some measures for selected meat and dairy products from Australia, Canada, and New Zealand. However, numerous regulatory differences remain in contention even between countries generally recognized as having rigorous regulatory standards that are rigorously enforced.

[8] More systematic assessment of the impact of equivalence in global food trade will be possible in the future as the result of the Committee's recent actions to increase the transparency of equivalence arrangements. The Committee revised its recommended procedures to provide for the notification of equivalence of SPS measures in 2001 and finalized the notification format in June 2002. In its Decision on the Implementation of Article 4, the Committee noted that equivalence could be accepted for a specific measure or measures related to a certain product or categories of products, or on a systemswide basis (WTO, 2001c).

Often, differences hinge not only on the equivalence of different process standards themselves, but also on how conformance with different standards is ascertained. There is inevitably more discretion in enforcement of process standards than for performance standards, which is why institutional capability and integrity figures so importantly in equivalence determinations. In many instances, equivalence is controversial because judgment about such matters, unsurprisingly, differs between exporters and importers. In other instances, there is disagreement between governments and domestic consumer groups.

Different views on the appropriate roles for the private and public sector in conformity assessment have likewise given rise to trade disputes among developed countries. For example, the United States rejected Australia's 1997 "Project 2" proposal to replace government officials with company-paid inspectors in meat export plants. Some Australian officials thought that this rejection lacked a legitimate rationale, but did not bring the matter to the WTO (*World Food Chemical News*, 1997b). U.S. regulators subsequently approved Australian exports under a revamped program that increased the role of government oversight, but redeployed government resources from traditional inspection duties to verification of control strategies, in line with changes being considered under USDA's HACCP-based inspection models project (USDA, 1999).

Differences over government and industry roles in certification have also held up EU recognition of the equivalence of the U.S. production and inspection systems for food-grade gelatin. U.S. exports to the EU have been suspended since June 2000, when the European Commission's new BSE-related regulations came into force. The European Commission has indicated that all U.S. gelatin safety measures, with the exception of two issues pertaining to the source of raw material and certain end-product specifications, are equivalent to corresponding EU measures. However, the EU is currently unwilling to import U.S. gelatin until there is more FDA oversight of industry self-certification of compliance with the two "non-equivalent" measures (WTO, 2002a).

Given the problems that developed countries have had with equivalence, developing countries have questioned whether this provision of the SPS Agreement will actually provide many export opportunities for them (WTO, 1998d). Some equivalence arrangements between developing and developed countries do exist,

especially for seafood products.[9] However, developing countries—echoing the claims of developed countries—have argued that developed countries often require "compliance" rather than equivalence of measures. Even developing countries that have had substantial success as agricultural exporters—such as Brazil, Mexico, and Thailand—have gone on record to note the difficulties in gaining recognition of equivalence (WTO, 1999; WTO, 2001a). Globally, the limited access to developed country markets for poultry meat illustrates both the potential and challenge of equivalence. Of the 144 countries that are WTO members, only 15 are eligible to export fresh, chilled, or frozen poultry meat to the EU, 4 may export to the United States, 1 can ship to Canada, and none are allowed to export to Australia.[10]

Developing countries aired their concerns related to equivalence and other SPS Agreement commitments in "implementation negotiations" undertaken by the WTO General Council in May 2000 after the 1999 Seattle Ministerial Conference failed to launch a new round of trade negotiations (WTO, 2001d). In response, the SPS Committee began to consider how it could advance implementation of the Agreement's equivalence provisions. To date, the Committee has identified options for expediting equivalence determinations, urged the international standards organizations to produce equivalence guidelines, and developed procedures to increase the transparency of such arrangements through notification (WTO, 2001c). The standards organizations quickly supported the WTO's initiative: both Codex and the OIE have completed draft guidelines for judging equivalence.[11]

Together, these efforts may further the objective of regulatory flexibility, but significant constraints remain. First, the administrative burden of equivalence determinations is often significant, involving evaluation of infrastructure, overall program design and implementation, and specific technical requirements. The United States has stated that its experience indicates the potential for equivalence may be limited because the actual trade benefits often do not justify this administrative burden (WTO, 2000).[12] Second, recognizing the equivalence of an alternative regulatory regime may require national regulators to offer the same alternative to domestic producers, requiring new or revised domestic regulations. Finally, measures may be specified in legislation, leaving little scope for regulators to consider other options. For example, the U.S. Egg Products Inspection Act of 1970 requires continuous inspection of processed eggs by government inspectors, a standard that is currently met by only one other country (i.e., Canada).

### *Harmonization*

The SPS Agreement's endorsement of harmonization stems from repeated complaints by exporters that complying with divergent SPS measures substantially increases the transaction costs of trade. Firms that ship products to several different markets stand to gain more from harmonization than from equivalence if harmonization results in lower production and certification costs per unit.

Harmonization can also benefit consumers, especially if the origins of regulatory heterogeneity are the result of chance events, information differences, or interest group capture. Harmonization is more likely to be inappropriate if incomes, tastes, and risks are the primary sources of variation in national regulations. Differences in risk perceptions, available market information, the incidence of risks in production, and traditional methods of food processing and preparation all lead to differences in food safety outcomes among countries. Thus, the benefits of a food safety standard may exceed its costs in one country, but not necessarily elsewhere.

[9] The EU, for example, has stated that 62 countries have been recognized as implementing an equivalent system of inspection and certification for fishery products; another 41 await equivalence evaluations, but can currently export fishery products to individual member States on the basis of bilateral agreements (WTO, 2002b).

[10] In addition to the four countries that are permitted to export fresh, frozen, and chilled poultry to the United States (Canada, Great Britain, France, and Israel), some plants in northern Mexico may also re-export U.S.-origin poultry meat to the United States after minimal processing.

[11] Codex adopted "Guidelines for the Judgement of Equivalence Agreement Regarding Food Imports and Export Inspection and Certification Systems" (GL-34) in 1999, but has yet to adopt its "Guidelines for the Judgement of Equivalence of Sanitary Measures Associated with Food Inspection and Certification Systems." The OIE's "Judgement of Equivalence of Sanitary Measures relating to International Trade in Animals and Animal Products" is also still under consideration by members.

[12] The United States has also cautioned that equivalence does not imply mutual recognition: under the equivalence provisions of the SPS Agreement, market access is contingent on a scientific determination that an exporter's alternative measure achieves the level of SPS protection required by the importer, not on reciprocity.

However, the impact of harmonization on trade appears to have been constrained as much by the lack of international standards as by normative considerations since the SPS Agreement came into force. The majority of 1995-99 notifications from WTO members stated that no international standard existed for the notified measure. Underinvestment in the development of international standards has led not only to too few international standards, but also to too many outmoded standards, which may account, in part, for the low adoption rate for those standards that do exist. Over the first 4 years of the SPS Agreement, partial or full acceptance of international standards as a percentage of total notified measures was highest for the lower-middle income countries (38 percent), followed by high-income (22 percent), lower income (20 percent) and upper-middle income countries (17 percent) (Roberts et al., 1999).

Still, international standards did settle some trade disputes. The OIE's continually updated assessments of potential vectors of BSE have been especially important in the wake of a crisis that has affected so many traded products. Countries cited OIE recommendations as the basis for resolution or partial resolution of 3 of the 13 "specific trade concerns" related to BSE measures. In these cases, Chile, India, and Slovakia (as well as Argentina) lifted bans on imports of dairy products or animal genetics as the result of the OIE's repeated assessments that these products would not transmit the disease (WTO, 2001a). The BSE outbreak has been a dramatic, but not isolated, example of a new hazard spawning new and extensive regulation. Information dissemination via international standards will be important not only to health authorities, but also to the trade system in these instances.

The nature of international standards is also important in assessing their impact on trade and trade disputes. Over the past decade, international standards organizations have allocated more of their resources to the development of metastandards—which identify common *approaches* to risk identification, assessment, and management—rather than international standards *per se*. Exporters' anticipated gains from international metastandards may be smaller than from international standards, as adherence to the same general guidelines still leaves scope for countries to develop different regulatory regimes for foodborne risks. For example, countries that follow Codex's 1997 General Principles of Food Hygiene guidelines, which provide a template for HACCP programs, still have substantive differences in their requirements for meat imports, as the EU's 1997 ban on U.S. poultry meat illustrates. Thus, the international standards organizations have contributed more to the trading system in recent years by setting out scientific approaches to regulation than by promulgating standards that are identical across adopting countries.

## Conclusions and Implications

Recent trends in food safety regulation create the potential for both more and less dispute in international food trade. Disputes may be eased by the similarity in regulatory trends and approaches among industrialized countries, such as the growing use of risk analysis and the adoption of HACCP requirements. Disputes may arise from the increased stringency of food safety standards; sudden actions taken in response to a food safety crisis; the difficulty of determining equivalence of risk outcomes from new process standards; differences in risk management approaches; and differences in the capabilities of countries at different levels of development.

The principles and mechanisms established in the SPS Agreement appear to be well-targeted to the potential sources of disputes, averting, diffusing, and resolving a number of food safety-related disputes since 1995. The SPS Agreement's requirements for transparency of regulatory regimes have promoted symmetry of information among WTO members. The establishment of the SPS Committee has provided a forum for airing grievances and made it easier to identify and track contentious regulations. These mechanisms have facilitated the resolution of disputes between countries at every level of development.

The large number of complaints by developed countries against the measures of other developed countries suggests that some gaps remain in convergence around SPS regulatory principles. The requirements to base measures on science and adopt minimally trade distorting measures still leaves scope for substantial disagreement among countries at the same level of development.

Differences in the use of precaution are one source of variation in food safety policies. Under the SPS Agreement, countries have been able to adopt measures that are substantially more conservative than the norm, as the EU's new aflatoxin regime illustrates.

Countries are also able to exercise caution by provisionally adopting measures to mitigate risks that are not fully understood. Most countries did so when the BSE crisis emerged in 1996, initially banning all bovine products from all 15 members of the EU. However, the right to exercise caution is balanced in the Agreement by the obligation to seek additional information to justify the permanent use of a measure, an obligation that benefited European exporters as more evidence emerged about the country/product sources of BSE risk. The balance struck by the SPS Agreement in the BSE case and in other instances seems to have accommodated legitimate variation in policies attributable to risk aversion or uncertainty, while disallowing trade restrictions that are based on protectionism or inertia.

The SPS Agreement has been less successful in reducing transaction costs to trade resulting from diverse regulations. Determining equivalence in risk outcomes has proven challenging. At a minimum, it may raise monitoring costs to determine that complex process standards are followed in the exporting country. Further difficulties arise when production practices and the incidence of risks vary widely across countries, making it difficult to determine if a process standard will lead to an equivalent risk outcome. Institutional barriers are also a factor, as when policy instruments are specified in legislation.

Thus, food safety standards, especially process standards, are likely to be contentious in international trade. The international standards organizations have improved the functioning of food markets, but more by improving the quality of regulation (which benefits consumers) than by reducing the transaction costs of exporting to different markets (which benefits exporters).

Multilateral institutions continue to work on an array of projects to improve the current governance of food safety and trade. For example, the Codex Commission aims to increase the relevance of its standards in international trade by adopting a "fast track" approval procedure for some standards, creating more working groups to address new issues, and increasing the number of its meetings to speed the adoption process. These institutional innovations are likely to lead to more immediate and concrete results than the continuing debate over the development of risk management principles. Other initiatives, such as the identification of the types of technical assistance that best help developing countries meet food safety requirements in key export markets, could also yield important benefits. But responsibility for increasing welfare-enhancing trade ultimately rests with national authorities who determine whether the spirit as well as the letter of their international obligations are fulfilled.

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*Chapter 4*

# International Trade of Meat/Poultry Products and Food Safety Issues

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## Summary

As our food system changes at all levels (consumption, production, and trade), these changes alter the nature and incidence of food safety risks. Greater consumer affluence and awareness of food safety issues tends to lead to a greater demand for safety. The three case studies in this chapter represent food safety issues that affect international trade of high-value meat and poultry products. The first case study is of Bovine Spongiform Encephalopathy (BSE) or "mad-cow disease," which began in the United Kingdom (UK) and has caused regulatory changes affecting both imports and market access worldwide. This case study shows that while live cattle and beef exports from the United Kingdom were decimated by three BSE crises (1988, 1996, and 2000), and have not recovered, total European Union (EU) exports of these products have been far less affected to date. For a brief period of time after each of the three BSE crises, EU domestic consumption of beef declined sharply. While EU domestic consumption of beef has gradually increased back to its long-term trend, prices have not recovered, suggesting some shift in demand. During the 1996 crisis, BSE became a human health issue when a connection between BSE and a new human variant of Creutzfeldt-Jakob disease (vCJD) was announced in the UK. BSE has affected the rendering industry and, because bovine byproducts and rendered products are used as intermediate inputs in so many products, effects have spread to the cosmetic, feed, medical, pharmaceutical, and other sectors.

The second case study, chosen to represent microbial food safety risks, focuses on *Salmonella* and covers the issue of zero or near-zero tolerance for *Salmonella* in poultry imposed by some countries. The *Salmonella* case study shows that many countries have trade restrictions for *Salmonella* in poultry and these restrictions vary by type (specific products or processing), extent (inspections of slaughter facilities, production practices), and duration, making compliance challenging for exporters. The technical ability to monitor and detect *Salmonella* and other pathogens is increasing and has led to major concerns about the difficulties in meeting the increasingly stringent or near-zero tolerance standards for *Salmonella* imposed by some countries. Also at issue is the inconsistency between standards for domestic and imported poultry.

Some foodborne pathogens, including *Salmonella*, have the potential to develop resistance to drugs used in livestock production so that the association of livestock drug use with drug-resistant foodborne pathogens and drug residues have potential implications for international trade. The third case study examines that issue, again using *Salmonella* as an example. There is accumulating evidence that some pathogens are becoming resistant to antibiotics. Some countries (for example, in the EU) prohibit the low-level (subtherapeutic) use of certain antimicrobial drugs as growth promotants in livestock production or have proposed such prohibitions based on their perception that there is enough evidence linking livestock drug use and human antibiotic effectiveness in treating foodborne illnesses, including salmonellosis.

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# Introduction

This chapter focuses on food safety concerns surrounding meat and poultry products and their associated impacts on international trade. These high-value products are widely traded internationally. The impacts from food safety concerns on meat and poultry trade are particularly important to the United States because of the high value and volume of U.S. exports of these products (table 4.1). U.S. exports of cattle, sheep, hogs, poultry, and many of their products account for roughly 10 percent of the value of cash receipts for those livestock species at the farm level. In terms of volume, about 20 percent of U.S. poultry production and 8.5 percent of U.S. beef production was exported in 2001. Although the United States is not a major importer of poultry, imports of meats and live animals are important, particularly imports of young live animals.

**Table 4.1—U.S. livestock product exports and imports**

| | Fiscal year | | | |
|---|---|---|---|---|
| | 2001 | 2002 | 2001 | 2002 |
| | —1,000 units— | | —$ million— | |
| ***Exports*** | | | | |
| Animals, live | — | — | 727 | 696 |
| Meats and preps., excl. poultry[1] (mt) | 2,442 | 2,590 | 5,193 | 5,113 |
| Dairy products | — | — | 1,121 | 1,031 |
| Poultry meats (mt) | 2,810 | 2,586 | 2,084 | 1,879 |
| Fats, oils, and greases (mt) | 1,049 | 1,339 | 320 | 454 |
| Hides and skins, incl. furskins | — | — | 1,933 | 1,776 |
| Cattle hides, whole | — | — | 1,437 | 1,121 |
| ***Imports*** | | | | |
| Animals, live | — | — | 2,198 | 2,022 |
| Meats and preps., excl. poultry[1] (mt) | 1,600 | 1,656 | 4,091 | 4,187 |
| Beef and veal (mt) | 1,056 | 1,067 | 2,645 | 2,749 |
| Pork (mt) | 399 | 439 | 1,039 | 992 |
| Dairy products | — | — | 1,728 | 1,841 |
| Poultry and products | — | — | 258 | 317 |
| Fats, oils, and greases (mt) | 106 | 99 | 62 | 63 |
| Hides and skins, incl. furskins | — | — | 162 | 136 |
| Wool, unmanufactured (mt) | 21 | 12 | 53 | 31 |

[1] Includes beef, pork, variety meat, and processing.

Source: *Agricultural Outlook* Statistical Tables, February 2003, accessed March 27, 2003: *www.ers.usda.gov/publications/Agoutlook/AOTables/AOTables.htm*

In the short run, meat and poultry trade varies due to year-to-year fluctuations in supply and demand. Supply may be affected by factors such as exchange rates and animal disease incidents that cause temporary trade restrictions. Demand factors that affect meat and poultry trade include changes in tastes and preferences, population growth, responses to food safety issues, and growth in income. Imports and exports for a particular sector may increase simultaneously due to differences in the supply and demand for different types of products produced within that sector. For example, U.S. consumers tend to prefer white poultry meat, and consequently the United States tends to export dark poultry meat. In general, poultry markets are subject to a mix of trade and national regulations combined with traditional and nontariff barriers (Orden et al., 2002). Historically, nontariff trade barriers have also been important in markets for other meats.

Meat and poultry trade has increased over time, and continued increases are projected over the next few decades, both in the United States and worldwide. World exports of poultry have increased dramatically and now account for about 10 percent of world consumption (Orden et al., 2002). Of all U.S. animal and crop exports, red meat exports increased the most over the last two decades. The 5-year average volume of U.S. red meat exports rose over 300 percent between 1981-85 and 1996-2000.

In its 1999 report on Animal Agriculture and Global Food Supply, the Council for Agricultural Science and Technology projected growth in international trade for livestock and livestock products, especially meat products (CAST, 1999). Predicting a 63-percent increase in global demand for meat through 2020, the CAST report attributed 88 percent of the projected increase to developing countries, with China accounting for half of that increase. Two specific reasons were cited for this projected increase in global demand for meat. First, increased urbanization due to increasing populations and rising incomes have increased per capita demand for meat, milk, and eggs. Second, increased global demand for meat reflects the increased demand for high-quality protein to improve children's growth, cognitive development, and health in countries where consumption of animal products is traditionally low. Meanwhile, per capita consumption of red meat has

declined in the United States (Haley, 2001) and in some other developed countries, although U.S. per capita consumption of poultry has increased (Regmi, 2001).

This growth in meat and poultry exports has been accompanied by several food safety disputes. From the perspective of the United States, perhaps the best-known market access problem arising out of a food safety issue is the 1989 beef hormone ban that adversely affected Canadian and U.S. exports of beef to the European Union (see box 4.1, "The Hormone Case…"). Other examples of food safety concerns negatively affecting U.S. exports of meat and poultry products include suspicion of *E. coli* on beef products exported to Japan and of *Salmonella* on poultry products exported to Russia. An example of how a food safety concern not endemic to the United States can still negatively affect U.S. production and trade is Bovine Spongiform Encephalopathy (BSE) in cattle and its potential link to variant Creutzfeldt-Jakob disease (vCJD). BSE is the focus of the first case study here, the second covers *Salmonella* in poultry products, and the third discusses drug resistance. These food safety issues have caused changes in policies and trade flows worldwide.

## Food Safety for Meat and Poultry

Ensuring food safety for internationally traded meat and poultry is particularly challenging because these products are perishable and can be contaminated by a variety of food safety hazards. Meat and poultry, along with other raw foods of animal origin (i.e., raw eggs, unpasteurized milk, and raw shellfish), are the foods most likely to cause foodborne illness outbreaks (CAST, 1994, p. 32).

Meat and poultry can be contaminated during production processes in many ways. In addition to physical contaminants like bones, hair, and other items, meat and poultry can also be contaminated with hormones, drugs, and other compounds that can leave residues in food, or by pathogens that can pass from animals or the environment to humans through contaminated raw food products or processing steps (table 4.2). Of bovine products, ground beef poses higher risks from *E. coli* O157:H7 than whole cuts of meat. The nature of ground beef is such that one hamburger may contain meat from many cows so any existing contamination can be spread throughout a batch of hamburger, making thorough cooking even more important.

Pathogens such as *E. coli* O157:H7 and *Salmonella* are commonly found in the gastrointestinal tract of animals and birds (Wells et al., 1998). Contamination of meat and poultry can occur during slaughter if the gastrointestinal tract is punctured or if there is contamination on the hides, feathers, and hoofs when animals enter the slaughterhouse (IFT, 2003; Feinman, 1979). During processing, poultry are eviscerated, then generally chilled in a cold water bath, and sprayed with a cleansing solution. The cold water bath is somewhat controversial because it can spread pathogens to previously uncontaminated carcasses. Beef animals are also eviscerated, and the carcasses are sprayed with a cleansing solution, but then they are air chilled rather than dipped in water.

In general, improvements in food safety, such as safe canning procedures, pasteurization of milk, and disinfection of water supplies have successfully contributed to the control of many foodborne diseases. Similarly, to improve meat and poultry safety, existing technologies, such as irradiation, and new technologies, such as steam pasteurization, continue to be developed, refined, and adopted.

## Links Between Animal and Human Health

More than 200 known pathogens are transmitted through food and pose human health risks (Mead et al., 1999). Many of the more important foodborne diseases are caused by pathogens such as *Salmonella*, *Campylobacter*, *Clostridium*, and *Listeria*, some of which are zoonoses.[2] Additional diseases are thought to be zoonoses, but conclusive evidence demonstrating the animal and human disease relationship is missing (e.g., Johne's disease in dairy cattle and Crohn's disease in humans (Collins, 1995; Thoen and Williams, 1994)). Some pathogens have changed or evolved recently into much more virulent strains (e.g., *E. coli* O157:H7 and *Salmonella* Typhimurium DT-104). Some strains of these bacterial pathogens have the added threat that through genetic variations, they have developed resistance to some antibiotic drugs.

The links between animal and human health are complex. In addition to the direct food safety links, there

[2] Zoonoses are disease-causing agents in both animals and humans and which can be passed between the two.

## Box 4.1—The Hormone Case and the WTO Dispute Panel

While there is some controversy whether the EU hormone ban is a measure to protect food safety or to protect EU beef producers, there is little doubt that it originated from consumer concerns about the effects of hormones on human health (Kerr and Hobbs, 2000). Roberts (1998) clarifies this point:

> The original ban was proposed in response to public anxieties that emerged in the late 1970s and early 1980s following widely publicized reports of 'hormone scandals' in Italy. In 1977, some northern Italian school children exhibited signs of premature development which investigators suspected was linked to illegal growth hormones in veal or poultry served in school lunches. Although exhaustive examination of possible causes of the abnormalities produced no concrete conclusion, a public furor rose over the use of hormones in livestock production. Then, in 1980, numerous supplies of veal-based baby food in Italy were found to contain residues of the illegal growth promotant diethylstilbestrol (DES), a synthetic hormone used as a feed additive to increase productivity in animal production (p. 386).

In response to these human health concerns, the European Commission (EC) banned the use of certain hormones for farm animals (Directive 81/602). In 1985, the EU further extended this ban to include all natural and synthetic hormones for growth promotion and prohibited imports of meat from animals using hormones (Directives 88/146 and 88/299). The import ban went into effect in January 1989.

In the only food safety disputes to advance to a World Trade Organization (WTO) dispute panel, the United States and Canada challenged the science basis for the EU ban on growth hormones in beef production. The EU's defense of its measure rested on its claims that the international standards for these hormones did not meet its public health goals and that the ban represented a precautionary approach to managing uncertain risks.

The WTO Appellate Body upheld the original panel's decision that the EU's ban violated the provisions of the Sanitary Phytosanitary (SPS) Agreement (Roberts, 1998). Both decisions affirmed the right of WTO members to establish a level of consumer protection higher than the level set by international health standards. The ban was nonetheless judged to be in violation of the SPS Agreement as it was not backed by an objective risk assessment (in violation of Article 5.1 and Article 3.3). The panel and judges also rejected the EU's use of the "precautionary principle" in its legal defense, as there is no explicit reference to this principle in the treaty. The SPS Agreement does recognize a *conditional* precautionary principle in Article 5.7, which allows countries to provisionally adopt measures "on the basis of available pertinent information" while seeking additional information "necessary for a more objective assessment of risk." However, the EU could not defend its permanent ban under this provision.

Significantly, the Appellate Body did overturn the panel's ruling that the ban violated Article 5.5, which requires countries to avoid variation in the levels of health protection provided by its SPS measures, if such variation results in discrimination or creates a disguised restriction on trade. The judges concurred with the panel that EU policies regarding the use of growth promoting substances in animals were "arbitrary and unjustifiable" as the EU allowed their use in pork. However, they disagreed that the ban was "a disguised restriction on trade," perhaps in deference to public anxieties that emerged in the late 1970s and early 1980s following widely publicized reports of illegal veterinary drug use in Italy and France. But although the Appellate Body was willing to acknowledge that the ban was originally motivated by "consumer concerns" rather than by protectionism, the overall outcome of the case suggests that the WTO will rule against measures based on popular misconceptions of risks as well as more overtly discriminatory measures.

The EU did not fulfill its obligation to bring its measure into compliance with the SPS Agreement by the May 1999 deadline, stating that it needed more time to complete risk assessments. The WTO consequently authorized the United States and Canada to increase tariffs on $128.1 million of EU exports until the EU complied with the ruling or provided compensation for the ban by lowering other trade barriers. The parties continue to discuss options such as increased market access for hormone-free beef and labeling, but the case has not yet been settled. Both the ban and the retaliatory tariffs remain in place.

*Box authored by Donna Roberts (ERS) and Laurian Unnevehr (University of Illinois)*

**Table 4.2—Animal diseases or pathogens that have human health implications[1]**

| Disease/pathogen | Source | Foods affected | Human diseases or conditions beyond gastrointestinal symptoms | Annual fatalities in U.S.[2] | Comments |
|---|---|---|---|---|---|
| **Prions** | | | | | |
| Bovine spongiform encephalopathy (BSE) | Cattle | Brain, nerve tissue, eyes, ileum | Variant Creutzfeldt-Jakob's disease (vCJD) | 0 (>115 worldwide since 1996) | BSE is always fatal in cattle as is vCJD in humans |
| **Bacteria** | | | | | |
| *Campylobacter* | Poultry, cattle, pork | Raw milk, poultry, beef, pork, shellfish | Reactive arthritis, Guillain-Barré syndrome | 99 | Leading cause of known bacterial foodborne illness in the U.S. |
| *Escherichia coli* O157:H7 | Cattle | Ground beef, raw milk | Hemolytic uremic syndrome (HUS) | 52 | Children under 5 years of age are particularly vulnerable to this pathogen and to HUS |
| *Listeriosis monocytogenes* | Many birds, mammals, and other animals | Hot dogs, luncheon meat, and numerous other foods | Sepsis, meningitis, bacteremia, acute febrile gastroenteritis | 499 | Can cause stillbirths and spontaneous abortions |
| *Salmonella* (non-typhoid) | Poultry, cattle | Meat, poultry, milk, eggs, and numerous other foods | Reiter's syndrome, reactive arthritis | 533 | Second leading known bacterial cause of foodborne illness in the U.S. |
| *Yersinia* | Swine | Pork, milk, or milk products | Joint pain | 2 | Most infections are uncomplicated and resolve completely |
| **Parasites** | | | | | |
| *Toxoplasma gondii* | Swine and contact with domestic cats' litter boxes | Pork, insufficiently cooked hamburger | Chronic reactive arthritis, Reiter's syndrome, miscarriage, birth defects | 375 | The primary source of infection for animals is feed contaminated with cat feces and possibly with rodent tissues. 30 to 60 percent of adults in the U.S. have *Toxoplasma* antibodies |

[1] According to the U.S. Centers for Disease Control and Prevention (CDC), more than 200 known diseases are transmitted through food. In the interest of space, this table is only a partial listing of source species, foods affected, and chronic complications.

[2]Annual human fatalities in the United States from all food sources provided by Mead et al. (1999) and by DEFRA (2002) for BSE.

Source: Adapted from CAST (1994), Frenkel (1990), Mead et al. (1999), Orriss (1997), Thoen and Williams (1994), and Reuters (5/15/96).

also appear to be tradeoffs between protecting human and animal health. For example, the use of antimicrobial drugs for livestock may protect animal health by reducing pathogens, but may pose some risks to human health through decreased effectiveness of some human antibiotics (CAST, 1994). However, scientific uncertainty surrounds these tradeoffs. Much remains unknown about the impacts of livestock drug use on human health. For example, while it is known that antibiotic use in livestock production can lead to an increase in the presence of resistant bacteria in livestock and farms, the actual origins of the resistant bacteria or the resistance factors are not known. Also unknown is the extent to which livestock drug use is responsible for human foodborne illnesses due to resistant bacteria.

Increased trade in livestock products also increases the risk of introducing pathogens or foreign animal diseases into countries. Risks from internationally traded products differ from risks from domestic products in at least one important respect. With livestock

products produced and consumed domestically, any animal and human health concerns stem from endemic diseases or pathogens, and responses to problems are often established and ongoing or evolving. Diseases or pathogens introduced through internationally traded livestock products may not be endemic and may pose a whole new set of problems unfamiliar to the importing country.

Foreign animal diseases can threaten trade and the economic health of the importing country and some pose potential threats to food safety and human health. Recent examples, not all of which are food safety concerns, include the Canadian BSE outbreak in 2003, the exotic Newcastle Disease outbreaks in the United States in 2002, the 2001 Foot and Mouth disease (FMD) outbreak in the UK, the 1997 FMD outbreak in Taiwan, the Avian Influenza outbreaks in Asia since 1995 and, the Avian Influenza outbreaks over the last decade in the United States. Not all of the foreign animal diseases in these examples caused food safety issues per se, but they did disrupt international trade in livestock products, and, in the case of the highly pathogenic form of Avian Influenza in Hong Kong, caused human deaths (Cardona, 2003).

# Case Study 1: Bovine Spongiform Encephalopathy (BSE)

Bovine Spongiform Encephalopathy (BSE) or "mad-cow disease" is a highly publicized food safety concern (see box 4.2). The associated human disease, a newly labeled variant of Creutzfeldt-Jakob Disease (vCJD), is believed to be caused by consuming BSE-contaminated meat. The BSE case study demonstrates how major changes in international trade regulations and standards for live cattle, bovine products, and many other products can result from a disease with a relatively low probability of infection but a high fatality rate. vCJD is always fatal and has caused over 115 deaths worldwide since 1996 (UK Dept. of Health, Sept. 9, 2002).

This case study chronicles three BSE episodes and their trade impacts on the EU (1988, 1996, and 2000). Because of data limitations on industry costs incurred to meet domestic and international food safety standards, trade volumes and values are used as proxies for measuring the effects from BSE.

## The Issue

BSE is a major food safety concern for several reasons, including: (1) the uncertainty of exactly how the disease is transferred to humans, which means that we have limited knowledge of how to prevent it, (2) the uncertainty of the total number of BSE and vCJD cases, partly due to the long incubation periods in both cattle and humans, (3) the inability to destroy the "prion," the agent believed to cause BSE and vCJD, (4) the lack of a cure for BSE and vCJD, and (5) the ability to confirm the presence of the disease only through postmortem testing. As we shall see, BSE is also a major animal health issue affecting production, consumption, and trade.

While cases of BSE have been found in many countries, over 95 percent of all BSE cases have been in the United Kingdom (UK) (table 4.3).[3] Estimated total costs to the UK alone from BSE-related market losses and for slaughtering, disposal, and selective cull schemes are over $5 billion (Watson, 2000). The BSE case study is presented chronologically and analyzes the less obvious impacts of BSE during the last 15 years on the volume and value of EU beef exports. The EU is the third largest beef exporter (after the United States and Australia). Understanding the impacts of a crisis like BSE is complicated as countries have many ongoing trade programs to meet the various domestic goals. EU trade policies are particularly complex and the introduction of new countries into the EU over time complicates the analysis of trade data series. The case study also provides a general discussion on the effect that BSE has had on countries worldwide, both on countries where BSE is endemic and where it is not, and the effects on other sectors beyond livestock and beef.

## The 1988 Episode: Emphasis on Animal Health Concerns

The first BSE episode occurred in 1988 with the discovery of about 2,500 cases of BSE-infected cattle in the UK. More BSE-infected cattle in the UK were

[3] No cases of BSE have been confirmed in the United States. A BSE risk assessment conducted by the Harvard Center for Risk Analysis and commissioned by the U.S. Department of Agriculture (USDA) shows that the risk of BSE occurring in the United States is extremely low and current early protection systems would prevent its spread here. Canada has experienced two cases of BSE, the first in 1993, and the second on May 20, 2003.

## Box 4.2—Bovine Spongiform Encephalopathy (BSE) and Variant Creutzfeldt-Jakob Disease (vCJD)

BSE is a chronic, degenerative disease affecting the central nervous system of cattle. The incubation period usually ranges from 2 to 8 years, and most cases in Great Britain have occurred in dairy cows between 3 and 6 years of age. Following the onset of clinical signs, the animal's condition deteriorates until it dies or is destroyed. There is no vaccine or treatment for BSE.

BSE was first discovered in 1986 in Great Britain and, to date, over 95 percent of all BSE cases have occurred in the United Kingdom (UK). However, while there has been a decline in the number of newly identified cases of BSE in the UK due to recent prevention and control efforts, cases have been confirmed in other European countries with new cases discovered in Austria, Finland, and Slovenia in 2001. No cases of BSE have been confirmed in the United States in over a decade of active surveillance. There have, however, been two confirmed cases in Canada.

In 1996, government officials in Great Britain announced that there was a possible link between BSE in cattle and a variant of Creutzfeldt-Jakob Disease in humans (vCJD). BSE in cattle and vCJD in humans belong to the family of diseases known as the transmissible spongiform encephalopathies (TSE), which cause the brain to have a spongelike appearance when examined under a microscope. vCJD is rare, invariably fatal, and characterized by progressive deterioration of brain tissue. The precise link between BSE and vCJD is unknown. However, many scientists now believe that humans contract vCJD by ingesting the causative agent, thought to be a prion or abnormal protein, in products made from brain, spinal cord, and some other organs from BSE-infected cattle (Lorains et al., 2001). In particular, epidemiological data suggest that BSE may have originally been caused by feeding cattle meat and bone meal made from sheep infected with a mutant form of scrapie or from feeding cattle protein contaminated with a previously unidentified TSE. Changes in rendering practices in the early 1980s may have enhanced the causative agent's survival in meat and bone meal, resulting in the recycling of infected cattle back to cattle. This increased the size of the epidemic. BSE is transmitted through contaminated feed and maternally. There is no evidence that BSE spreads through contact between unrelated adult cattle (e.g., within a herd) or from cattle to other species by contact.

Currently, tests cannot detect BSE in living cattle or vCJD in living humans. Microscopic postmortem examination of brain tissue and tests for prion protein are the primary laboratory methods used to confirm a diagnosis. As of September 2, 2002, vCJD had caused 115 deaths in the UK (UK Dept. of Health, 2002), and there have been some deaths outside of the UK (e.g., in France and the Republic of Ireland). No cases of vCJD have been detected in the United States except for one individual who had lived in the UK.

BSE has had a substantial impact on the UK's livestock industry and has altered international trade patterns. As of May 30, 2003, 180,078 head of cattle on 35,796 farms had been diagnosed with BSE in Great Britain. These animals, herdmates, and progeny, totaling over 5 million head, were destroyed. Even though there have been no confirmed cases of BSE or vCJD in the United States, the threat of BSE has increased consumer concerns about food safety and has caused the United States to impose international trade restrictions and to increase expenditures for BSE surveillance and other measures in order to protect animal and human health.

*Source: Adapted from Buzby and Detwiler, 2001.*

quickly discovered, with over 7,000 additional cases in 1989 and a peak of 37,000 cases in 1993 (fig. 4.1). This BSE outbreak was not really considered a food safety issue at the time, and early trade restrictions were imposed largely in response to the effects of BSE on animal health. By mid-1989, Australia, Israel, New Zealand, Sweden, and the United States had banned imports of live cattle from the UK, while Canada, Japan, Morocco, and South Africa introduced requirements that live cattle imports from the UK be certified as BSE-free. These trade restrictions caused a significant decline in UK live cattle exports. By 1990, UK live cattle exports were little more than a fifth of their 1988 level and have never recovered (table 4.4). UK exports, however, constituted only a small share of EU exports even before BSE, and restrictions on UK cattle did not have a commensurate effect on either EU or world live cattle trade. Indeed, total EU live cattle

**Table 4.3—Number of reported cases of BSE in cattle in the United Kingdom[1] and worldwide[2]**

| Country | Reported cases |
|---|---|
| United Kingdom | 180,078 |
| Ireland | 1,274 |
| France | 829 |
| Portugal | 787 |
| Switzerland | 432 |
| Spain | 302 |
| Germany | 253 |
| Belgium | 113 |
| Italy | 88 |
| Netherlands | 60 |
| Denmark | 13 |
| Slovakia | 12 |
| Japan | 7 |
| Czech Republic | 5 |
| Poland | 5 |
| Slovenia | 3 |
| Canada | 2 |
| Liechtenstein | 2 |
| Luxembourg | 2 |
| Austria | 1 |
| Finland | 1 |
| Greece | 1 |
| Israel | 1 |

[1] Source: May 30, 2003, data from Department for Environment, Food and Rural Affairs (DEFRA)(2001), *www.defra.gov.uk/animalh/bse/bse-statistics/bse/general.html* accessed July 23, 2003.

[2] Source: Feb. 21, 2003, data from the Office International des Epizooties (OIE) website. See original table on OIE website for details and caveats about cases by year of confirmation: *www.oie.int/eng/info/en_esbmonde.htm*

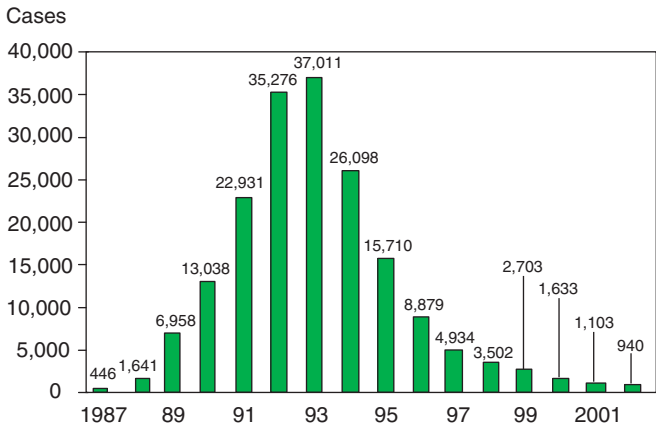
exports expanded between 1989 and 1996. Austria, Finland, and Sweden joined the EU in 1996, accounting for part of this increase (i.e., membership was 12 countries during 1988-1995 and 15 countries during 1996-2001).

The 1988 BSE outbreak also affected UK beef exports, but not as much as exports of live cattle. By early 1991, many countries had imposed bans on imports of UK beef, and other countries had placed stringent certification requirements on beef imported from the UK (e.g., Cyprus and Hong Kong).[4] One beef subcategory, UK exports of bone-in beef to other EU countries, showed a significant decline between 1990

[4] Countries that imposed bans include Algeria, Bahrain, Brazil, Canada, China, Egypt, Iran, Iraq, Jordan, Morocco, Saudi Arabia, Syria, Tunisia, Turkey, United Arab Emirates, and Russia.

Figure 4.1

**Confirmed cases of BSE in the United Kingdom by year of clinical onset peaked in 1993**




Source: Crown copyright, 2002. UK Department for Environment, Food and Rural Affairs (DEFRA) website *(www.defra.gov.uk)* by permission of HMSO Licensing Division.

and 1991, but then quickly recovered in later years, surpassing its pre-1988 levels.[5] UK exports of boneless beef also declined in the first few years after the 1988 outbreak, but had fully recovered by 1995.

The 1988 outbreak had little long-term effect on total volume of EU beef exports. While the volume of EU exports increased by 5 percent between 1988 and 1990, the value of these EU beef exports declined by almost 37 percent with most of the decline between 1988 and 1989, suggesting a downward shift in demand (table 4.4).

## The 1996 Episode: A Switch to Human Concerns

The 1996 BSE episode began with the discovery of BSE-infected cattle in EU countries outside the UK (France, Ireland, and Portugal) and a March 1996 announcement of a potential link between vCJD and eating BSE-infected meat. By 1996, 13 vCJD cases had been reported in the UK. Media reports highlighted the slow, agonizing death suffered by vCJD patients as well as a perceived inability of UK and EU authorities to understand and control the spread of BSE and vCJD. Although, the number of newly confirmed BSE cases in the UK in 1996 was almost half of those discovered in the previous year (DEFRA, 2002), long incubation periods for BSE and vCJD

[5] The UK was never a large exporter of bone-in beef in any case.

**Table 4.4—EU (excluding intra-trade) and UK (extra-EU) exports of live cattle and beef, 1988-2000**

| | Live cattle | | Beef | | | |
|---|---|---|---|---|---|---|
| | EU[1] | UK | EU[1] | UK | EU[1] | UK |
| | — Head — | | — Metric tons — | | — Million US$ — | |
| 1988 | 60,627 | 315 | 615,360 | 27,475 | 1,945.4 | 75.6 |
| 1989 | 61,187 | 249 | 851,240 | 26,554 | 1,340.1 | 66.6 |
| 1990 | 68,212 | 66 | 647,059 | 16,457 | 1,230.9 | 33.4 |
| 1991 | 161,879 | 41 | 1,026,691 | 24,159 | 1,382.4 | 49.0 |
| 1992 | 169,447 | 82 | 972,385 | 19,789 | 1,472.8 | 50.2 |
| 1993 | 286,542 | 16 | 829,198 | 34,490 | 1,229.3 | 69.0 |
| 1994 | 295,830 | 31 | 784,609 | 45,931 | 1,259.0 | 85.0 |
| 1995 | 387,787 | 33 | 730,159 | 50,395 | 1,171.7 | 93.3 |
| 1996 | 501,828 | 0 | 727,848 | 12,535 | 1,167.9 | 23.2 |
| 1997 | 287,119 | 0 | 740,465 | 401 | 1,132.6 | 0.0 |
| 1998 | 266,225 | 0 | 521,789 | 151 | 888.3 | 0.0 |
| 1999 | 330,758 | —[2] | 694,054 | 165 | 1,018.1 | 0.0 |
| 2000 | 306,982 | 3 | 433,282 | 181 | 585.2 | 0.0 |
| Nov-00 | 25,575 | 0 | 38,841 | 42 | 60.6 | 0.0 |
| Dec-00 | 13,356 | 0 | 27,275 | 26 | 40.6 | 0.0 |
| Jan-01 | 12,205 | 0 | 26,850 | 4 | 34.5 | 0.0 |
| Feb-01 | 6,377 | 0 | 34,786 | 13 | 38.3 | 0.0 |

[1] Austria, Finland, and Sweden joined the EU in 1996. Therefore, data represent EU-12 during 1988-95 and EU-15 during 1996-2000.
[2] Number not confirmed.

Source: Eurostat and H.M. Customs and Excise.

caused concerns about how high human and animal illness tallies would reach.

Evidence of a link to vCJD quickly turned BSE from an animal health issue to a food safety issue. The EU temporarily banned all UK beef exports to other EU countries and the rest of the world. Additionally, most countries imposed a total ban on imports of beef and live cattle from the UK, and several countries also imposed either a ban on beef or live cattle from the EU or a ban on imports from those European regions where BSE was discovered. Between 1995 and 1997, UK exports of beef to non-EU countries dropped by 99 percent and exports to EU countries dropped by 97 percent. UK exports of live cattle, already at very low levels as a result of the 1988 episode, fell to zero.

Outside the UK, there were fears that the 1996 BSE episode would affect total EU and world beef consumption and trade for years, if not permanently. A series of media reports predicted that the sudden drop in beef consumption in some EU member states (sometimes by as much as 20 percent) would last for a long time and would quickly spread to other countries and regions outside the EU. Several international consumer, environment, and health advocacy groups implied that BSE in the EU was a sign of a large, worldwide epidemic and recommended eating other meats besides beef or switching to a more vegetarian diet.[6] There were fears that BSE could eventually spell the demise of the entire beef market.[7]

In retrospect, these fears were exaggerated. Total EU exports of beef barely declined in the first couple of years after the second episode (1996-1997) and sales from the world's major beef exporters either remained stable or increased over this time.[8] Not until 1998 did EU beef exports decline considerably, about 30 per-

[6] Examples include: (1) "Worldwide Meat Trade Might Have Spread Disease," *International Herald Tribune*, Dec. 23, 2000; (2) NOVA television program, "The Brain Eater," Aug. 17, 1999; (3) MSNBC report "Where's the Beef," March 23, 2001; and (4) *E-The Environment Magazine*, "The Case Against Meat," Jan./Feb. 2002.

[7] "Worldwide Meat Trade Might Have Spread Disease," *International Herald Tribune*, Dec. 23, 2000.

[8] World exports of beef and pork increased steadily between 1992 and 2000 (USDA, Sept. 2001).

cent, but that decline was due more to a downturn in the Russian economy than to any long-term decline in world import demand. In fact, world beef imports remained steady between 1995 and 2000. After 1998, as the Russian economy started improving, so did EU beef exports, increasing 33 percent between 1998 and 1999. The 1999 depreciation of the Euro also made EU export refunds less expensive and EU beef exports more attractive.[9] Although BSE spread to other countries both within and outside the EU from 1996 to 1999, the outbreaks were usually limited to one or two cases at a time and did not cause a worldwide panic until later in 2002, when new cases were identified in Japan and Israel.

Several reasons account for why the 1996 BSE episode had a much smaller and shorter-term effect on import demand and exports than some had predicted:

(1) Predictions of a large, permanent switch from beef consumption to consumption of other meats or a more vegetarian diet as a result of BSE were exaggerated.[10] While EU consumers are consuming more pork and poultry and less beef per capita over time, this trend is a gradual one. The source of this long-term trend is likely caused by long-term changes in the eating habits and demographics of EU consumers, and not driven primarily by food safety issues such as BSE and growth hormones (EC, 1997; EC, 1998). However, short-term changes in EU meat consumption may be caused by information about BSE and its associated risks described in the press (Verbeke et al., 2000; Verbeke and Ward, 2001).

(2) After the 1996 episode, the UK adopted an extensive set of programs to ensure that cattle used for beef production were BSE-free. These actions included the Over Thirty Month Cattle Slaughter Rule, which as the name implies, mandated that all cattle over 30 months of age be destroyed (BSE is not believed to affect cattle below this age) and a ban of all meat and bone meal (thought to be a carrier of BSE) in cattle feed. These actions led to fewer BSE cases in the UK from 1996 to 2001 (fig. 4.1). Many EU countries also adopted similar initiatives.

(3) During 1996-99, both EU beef consumption and production were below pre-BSE levels, leaving export quantities virtually unchanged. This helped stabilize the EU beef market.

(4) Prices for cattle and beef from the UK and the EU also declined, implying a downward shift in demand in response to risks associated with beef consumption. These price declines helped move products in markets that might otherwise have shown decreases in quantities traded (fig. 4.2 and table 4.4).

## The 2000 Episode: A Widening Epidemic

The October 2000 BSE episode occurred just as EU initiatives to bring stability to the domestic beef market had started to be effective. Like the 1996 episode, the 2000 BSE episode was prompted by the discovery of more BSE cases in European countries outside the UK.[11] Also of importance, the first vCJD cases were discovered outside the UK in France and received a lot of media attention. The discovery of BSE in countries outside the UK was in part due to increased postmortem testing of cattle. By 2001, every EU country had reported at least one case of BSE.

The trade effects from the October 2000 BSE episode were felt immediately. EU beef exports dropped 30 percent between November and December 2000, while remaining UK beef exports fell by almost 40 percent (table 4.4). Despite this being the third BSE episode in the EU, EU beef exports appear to have quickly recovered in the following months. Between January and February 2001, EU beef exports had risen almost to their pre-December 2000 levels. Even UK beef exports showed some signs of recovering during this period, although they were nowhere near their pre-BSE levels. The drop in EU exports during December 2000 did not

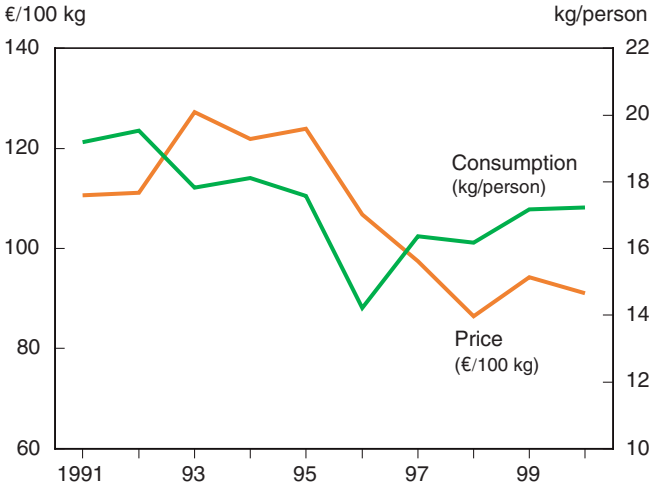
[9] The declining value of the Euro against many currencies reduced the export subsidy (difference between the world price and EU intervention price for beef) to practically nothing. This allowed the EU to export beef without fear of violating their WTO commitments on export subsidies.

[10] Adda (forthcoming) analyzed panel data from 2,798 French households before and after the March 1996 announcement linking BSE to vCJD (between Jan. 1, 1995, and June 24, 1996) and found no evidence of participants' becoming vegetarian, although households did reduce their expenditures on beef and switched to other animal protein substitutes.

[11] In 1996, Portugal reported 31 BSE cases, France reported 12 cases, and Ireland reported 74 cases of BSE. In 2000, Portugal reported 150 cases, France 162 cases, and Ireland 149 cases.

Figure 4.2

**Nominal EU beef prices and consumption, 1991-2000**




Source: OECD. Directorate for Food, Agriculture, and Fisheries.

cause a drop in world beef exports, as exports from the United States and Australia made up the difference. Measures added by the EU in January 2001 to ensure the safety of the beef supply may have helped dampen the impact of this crisis. For example, the Over Thirty Month Cattle Slaughter Rule was extended to other EU members and a ban was imposed on all animal feed (not just cattle feed) containing meat and bone meal. USDA's Economic Research Service (ERS) estimates that this EU ban on meat and bone meal feeding will cause the EU to import an additional 1.5 million tons of soymeal per year to replace meat and bone meal in livestock feed rations (USDA, 2002).

In February 2001, a major FMD epidemic broke out in the UK and spread to other EU countries, affecting EU trade of cattle, swine, and sheep and their products (Buzby et al., 2001; Mathews and Buzby, 2001). Because FMD is infectious through live animals and their products and countries typically stop exporting these products when FMD is confirmed, this FMD outbreak led to temporary market closures, affecting world exports and imports of these products (FAS, Oct. 2001). By the following month, EU beef exports had fallen by more than 80 percent due to FMD, a larger decline than during any of the three BSE crises.

## Conclusions From the BSE Case Study

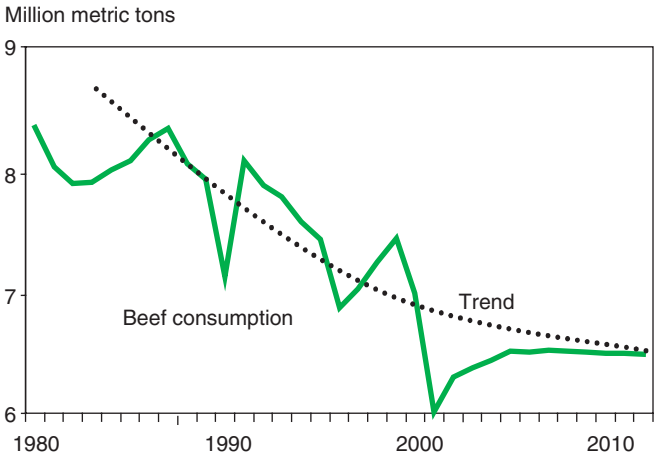
Although UK exports of live cattle and beef plummeted to nearly zero as a result of the three BSE crises and have not yet recovered, the total volume of EU exports has been much less affected to date. Also, for a brief period of time after each BSE episode, domestic consumption in the EU declined sharply but then gradually increased to resume its long-term, downward trend (fig. 4.3). This longer-term trend in beef consumption began before the first BSE crisis. In essence, the effects of BSE on EU beef consumption and trade volumes were short-lived. Both the official USDA and European Commission forecasts predict a similar pattern for the future, estimating that long-term patterns in beef consumption and trade volumes for the next 6 to 8 years will not be greatly affected by BSE (see box 4.3) (EC, 1998; USDA, 2002).

EU beef prices, however, did not recover following the three episodes, suggesting a downward shift in demand for beef and severely affecting trade values. A number of studies provide additional evidence that consumer demand in the UK and EU has shifted downward due to BSE (Burton and Young, 1996; Verbeke, et al., 2000; Lloyd, et al., 2001; Verbeke and Ward, 2001; Henson and Mazzocchi, 2002). The 3-year average value of EU beef exports fell by 45 percent between 1988-90 and 1998-2000, largely because of the decline in prices (figs. 4.2 and 4.3).[12] Other factors also affected prices, including changes in EU country currencies associated with adoption of the Euro (Bowles, 2003). Jin and Koo (2003) found evi-

[12] Negotiations are currently underway to resume UK exports to Russia and Egypt, so UK exports may show improvement in the near future.

Figure 4.3

**EU domestic beef consumption during the three BSE crises (1988, 1996, and 2000)**



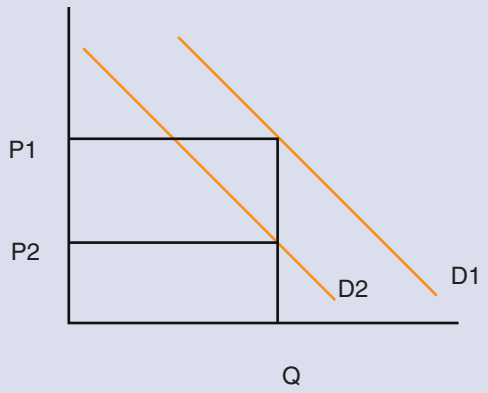

Source: USDA Production, Supply, and Distribution database, 1980-2001; baseline projections, 2002-2011.

## Box 4.3—Consumption Versus Demand

Some distinctions should be made regarding consumption and demand. First, consumption and demand are not the same. For a commodity, consumption is production plus imports minus exports and net of changes in storage stocks. For example, all the beef that is produced and imported will be consumed (or exported or wasted) at some price. Beef production is generally stable due to cattle cycles and long production lags except for all but the most drastic changes in cattle inventories like the 30-month cull for BSE or the 2001 depopulation of livestock in the UK due to foot-and-mouth disease. If consumption remains relatively constant or continues on a downward trend, as beef consumption appears to have done in the UK, a quick glance at prices may give some indication about what is happening to demand. Demand is an economic term representing the quantity removed from the market for each price. Demand is affected by income, prices of substitute and complementary products, and other factors.

Recent studies have argued that while EU beef *consumption* may have recovered (Q below), beef demand has not (Thompson and Tallard, 2003). Significantly lower prices (e.g., a move from P1 to P2 in the figure below) for relatively similar quantities of beef consumption (Q in the figure below) indicate a downward shift in demand in the UK (Lloyd et al., 2001; Atkinson, 1999) (move from D1 to D2 in the figure). Earlier, Burton and Young (1996) attributed a "long-term" loss in UK beef's market share of 4.5 percent to the first BSE outbreak. Prices have not recovered relative to consumption. Whether the same demand shifts are observed for the EU has not yet been demonstrated in the literature.

Most economic forecasts do not predict any long-term trade or consumption effects from the BSE crises in the EU. However, these forecasts are based on the assumption that EU beef consumption has fully recovered or is fast approaching its long-term trend. If beef consumption is still short of what demand would have been in the absence of BSE, it would indicate that studies have underestimated the effects of BSE on demand and, consequently, trade that is, trade effects from BSE would be larger if demand were taken into account. More research needs to be completed on this topic.




dence for changes in consumer demand for beef in Japan, which they attributed to BSE, despite accounting for other factors, such as changes in importing countries' real income levels, third-country effects, and exchange rates.

Although some developed countries are changing their consumption patterns away from red meat (such as the United States and EU), world beef exports have increased during the past 12 years, largely due to middle-income countries' increasing their beef consumption (Regmi et al., 2001). This worldwide increased demand for beef along with price declines in the EU, indicative of a downward shift in demand in the EU, have moderated the decline in total EU beef export quantities. In general, fears of eating UK beef because it might be tainted with BSE have not spread to fears of eating beef from the EU. This is partly due to new EU efforts such as slaughtering schemes and feed restrictions that help assure consumers that the EU beef supply is free of BSE contamination. Nor have fears of eating UK beef spread to consumption of other livestock species.

BSE has caused countries to impose numerous additional safeguards to protect animal and human health. In addition to the Over Thirty Month Cattle Slaughter Rule and EU bans of meat and bone meal in all animal feed, BSE-related safeguards to protect animal and human health include surveillance systems, new regulations for domestic production, and international trade restrictions. Countries that do not have endemic BSE (the United States, for example) have also imposed regulations, import restrictions, and other measures to prevent the disease from crossing their borders and to mitigate its impact if it should be found. For example,

as a result of BSE, the United States enacted a regulation prohibiting meat and bone meal in all ruminant feed. In addition to policy changes in response to BSE, markets have also changed. For example, U.S. beef exports to Japan have not yet recovered from Japanese consumers' responses to their domestic BSE outbreak.

In turn, as safety standards are raised worldwide, market access for some exports from both endemic and nonendemic countries has been affected. For example, EU regulations related to BSE are preventing the importation of U.S. gelatin into the EU until all U.S. production and inspection systems and measures are found to be equivalent to those in the EU (see chapter 3). This is occurring even though the U.S. has not had any cases of BSE.

In addition to gelatin, feed, livestock, and beef, BSE has affected many other sectors, including the rendering industry and cosmetic, medical, and pharmaceutical sectors. The indirect effects on so many other sectors occur because bovine byproducts and rendered products are commonly used as intermediate inputs in many products. Consequently, trade restrictions affect many sectors. Some of these restrictions are not supported by science. For example, many countries suspended imports of European dairy products following the 1996 BSE crisis and then later rescinded these bans when the World Health Organization and the International Office of Epizootics for animal and human health measures reaffirmed that existing scientific data did not identify these products as BSE vectors (see chapter 3).

Policy changes associated with BSE have resulted in significant disruptions to international trade. As discussed in chapter 3 of this report, the number of complaints (or counter notifications) to the World Trade Organization related to the regulation of transmissible spongiform encephalopathies, which include BSE, account for nearly half of all counter notifications related to food safety regulations since 1995.

## Case Study 2: *Salmonella* and International Meat Trade

Unlike vCJD, which has claimed relatively few lives worldwide (115 in the UK as of Sept. 2, 2002, according to the UK Dept. of Health), foodborne pathogens cause an estimated 5,000 deaths annually in the United States alone, out of an estimated 76 million foodborne illnesses (Mead et al., 1999). Foodborne pathogens affect international trade through standards and regulations adopted by countries and sporadic bans on shipments of specific items.

In addition to other measures described later in this chapter, countries commonly use import bans to reduce food safety risks. Because the term "ban" is used in many ways, we make a distinction between bans and standards in this chapter. We use "standards" to refer to laws, rules, or regulations that establish the food safety standard for a country and that remain in place over time. An example of a standard is the requirement by some countries that all imported poultry must be cooked or canned. We use "bans" to refer to short-term or sporadic responses by a country to infractions of their standards; bans usually apply to specific shipments for specified periods. An example of a ban is the denial of access to a country of a specific shipment of poultry that tested positive for *Salmonella* contamination at the port of entry. Here, "bans" may also apply to narrow groups, a company for example.

World poultry trade for the 5 years ending in 2002 amounted to about 11-12 percent of world poultry production.[13] With meat and poultry consumption expected to increase in future years (CAST, 1999), this export share of world production will likely increase despite the divergent sanitary and phytosanitary (SPS) standards across countries and despite the likelihood that increased poultry exports will come from the few countries (Brazil, Canada, China, EU, Hungary, Thailand, and the United States) already exporting 80 percent of poultry and poultry products. The variety in SPS standards that importing countries impose on exporting countries has contributed to the number of disputes raised to the WTO SPS Committee (Orden et al., 2002). Complaints referencing poultry products accounted for 8 percent of total cross notifications raised within the first 5 years of the SPS Committee's authority (Orden et al., 2002). These disputes can disrupt trade.

While several types of pathogens have been identified in animal product imports and have resulted in trade interventions (e.g., *E. coli* O157:H7 and *Campylobacter*), *Salmonella* appears to be the most contentious in terms of trade disputes. For example, *Salmonella* is the only

[13] USDA, *Agriculture Outlook* Statistical Tables, table 23, *www.ers.usda.gov/publications/Agoutlook/AOTables/*, as accessed on April 17, 2003.

pathogen mentioned by name as a trade concern in poultry import requirements imposed by many countries. Therefore, this second case study focuses on *Salmonella* and its implications for food safety and international trade.

Each year in the United States alone, nontyphoidal *Salmonella* causes an estimated 1.3 million cases of foodborne illness, 15,608 associated hospitalizations, and 553 deaths (Mead et al., 1999).[14] The proportion of illnesses attributed to *Salmonella*-contaminated meat and poultry is unknown. More severe cases of salmonellosis tend to occur in the very old, the very young, and the immunocompromised. Human illness from foodborne *Salmonella* has a higher infection rate than vCJD but a lower fatality rate. *Salmonella*-related food safety issues are important to international trade for several reasons:

(1) *Salmonella* contamination occurs in a wide range of internationally traded animal and plant products, including poultry, eggs, beef, pork, dairy products, seafood, and fruits and vegetables.

(2) *Salmonella* is a common cause of foodborne illness worldwide and the second leading bacterial cause of foodborne illnesses in the United States, following *Campylobacter*.

(3) *Salmonella* is the leading cause of death attributed to known foodborne illnesses in the United States (Mead et al., 1999).

(4) Many countries impose *Salmonella* restrictions that limit trade in meat and poultry products.

(5) Such restrictions are sometimes inconsistent with domestic standards or are applied more strictly on imports.

(6) Some national standards are based on zero—or near zero—tolerances, levels that are difficult to achieve. These standards and restrictions are inconsistent between countries and lack a widely accepted scientific foundation.

(7) Countries vary in their commitments and resources allocated to reducing *Salmonella* at the various production, slaughter, and processing stages, which have spillover effects to trade. *Salmonella* is very difficult to control, although some countries, particularly Scandinavian countries, have invested large amounts of resources to minimize this pathogen in hog operations (Hayes et al., 1999) and in poultry (e.g., see Molbak et al., 1999, for Denmark). Developing countries have fewer resources to devote to reducing *Salmonella* in food production to meet strict tolerances. Additionally, countries may have reduced incentives to devote more resources to *Salmonella* reduction if other disease problems prevent them from exporting in international markets, such as endemic International Office of Epizootics (OIE) List A diseases (diseases with potential for rapid spread and serious socioeconomic consequences) (Seitzinger, 2002).

The primary issue in this case study concerns the range of importing countries' tolerance standards for *Salmonella* contamination in poultry. Because of data limitations, the *Salmonella* case study describes the pathology of the disease and the trade restrictions imposed by various countries.

## Concerns About a Range of Tolerance Standards for *Salmonella*

The WTO Agreement on the Application of Sanitary and Phytosanitary Measures in April 1994 (see chapter 3) gives each WTO member the right to determine its own level of SPS protection. Countries impose different standards and regulations to handle the risks of pathogen contamination from processing and other stages of production. For example, U.S. producers commonly add chlorine to the cold water bath to reduce pathogen levels in poultry while some countries do not allow chlorine to be used for domestic or imported poultry. Countries' trade restrictions for *Salmonella* in poultry vary by type of restriction (by specific products or processing methods), extent (inspections of slaughter facilities, production practices), and duration of the trade interruption. For example, some countries require certification of slaughtering and processing facilities while others rely on exporters' domestic inspection systems. These diverse national standards make compliance challenging for exporters, particularly if the standards have zero or near-zero tolerances for *Salmonella*.

[14] Salmonellas are divided into two groups in the human health literature, typhoidal and non-typhoidal. Typhoidal *Salmonella* causes typhoid fever, a disease associated with contaminated water and poor sanitation, while other salmonellas cause foodborne illnesses. There is also a group of salmonellas that causes diseases in birds or animals, but not in humans.

Two main concerns arise when countries impose near-zero or zero tolerances for *Salmonella* contamination in imported meat products, especially poultry. First, a zero risk may not be feasible from either a policy or producer standpoint. In the case of *Salmonella*, a zero-risk policy may keep out all imports. Some scientists believe that *Salmonella* is ubiquitous in the environment and that continuous testing will find it, particularly with increased precision of diagnostic tools. Second, for most risks, the cost to achieve further risk reductions increases as the risk level approaches zero. Costs of preparing poultry products to meet zero-tolerance import standards of some countries would be in addition to costs incurred from the implementation of Hazard Analysis and Critical Control Point (HACCP) measures required of U.S. federally inspected meat and poultry processors and slaughterhouses (USDA, July 25, 1996).[15] As part of HACCP, USDA's Food Safety and Inspection Service (FSIS) tests raw meat and poultry products for *Salmonella*.

The range of standards can be seen in FSIS library of countries' export requirements. Table 4.5 presents data on *Salmonella*-related requirements for the top 10 importers of U.S. broilers.[16] Russia and Estonia currently require *Salmonella* testing of certain imports and have low- or zero-tolerance policies, and Japan explicitly reserves the right to test for *Salmonella*.

Although only 3 countries covered in table 4.5 have *Salmonella*-specific requirements, other countries have regulations that indirectly deal with *Salmonella* and other foodborne pathogens. For example, some countries reserve the right to subject imports to general microbial testing, which would likely include testing for *Salmonella* and which would lead to the rejection of shipments that test positive for *Salmonella*. Chile was also included in the table as it provides an example of a different standard. Chile effectively imposes a zero-tolerance regulation for imports by declaring that fresh/frozen (raw) poultry is not eligible for importation; only fully cooked or canned poultry products are eligible (FAS, 2002). As proper cooking and canning kills *Salmonella*, this regulation means that the allowed imports are *Salmonella*-free. Bilateral consultations between the United States and Chile on *Salmonella* began as early as 1992. Historically, the United States has been concerned that Chile holds poultry imports and its domestic poultry to different *Salmonella* standards and that Chile has not substantiated the claim that *Salmonella* is more prevalent in imports from the United States than in Chilean poultry stocks (WTO, 2001).

In addition to Chile, four other countries (the Czech Republic, El Salvador, Honduras, and Slovakia) applied zero-tolerance standards for *Salmonella* in 1996, according to the WTO (2001). Like the U.S. response to Chile, the U.S. response to these four countries in October 1996 was that this standard was discriminatory because these countries did not have eradication and surveillance systems capable of reaching this high standard in domestic products, yet expected imports to follow this standard (WTO, 2001). Negotiations between the United States and these five countries on *Salmonella* standards continues.

There are several examples where U.S. poultry exports to Russia, the Ukraine, and other countries have been periodically interrupted when *Salmonella* contamination was found in shipments or suspected in imported meat or poultry products. In 1995, Russia was the leading importer of U.S. poultry meat, importing about 1.6 billion pounds of broiler and turkey meat valued at almost $600 million (not including indirect shipments through Baltic countries). Requests to certify the absence of *Salmonella* was a key issue of contention in 1995-96, when Russia threatened to embargo U.S. poultry meat exports. The Russian position on this threatened embargo was based on the claim that U.S. poultry products did not meet the health requirements set forth in a 1993 bilateral agreement regarding *Salmonella* standards. This claim was partly based on some legitimate concerns (e.g., a spoiled shipment of frozen U.S. poultry meat in June 1995). The threat of this ban prompted Tyson Foods Inc., the largest U.S. poultry producer, to announce plans to scale back pro-

[15] HACCP systems identify potential sources of pathogen contamination and establish procedures to prevent contamination and their transmission to humans through food. HACCP plans generally follow seven steps: conduct a hazard analysis; identify critical control points (CCP) for physical, biological, and chemical hazards; establish critical limits for preventive measures associated with each CCP; establish CCP monitoring requirements; determine and perform corrective actions; establish recordkeeping systems; and conduct verification procedures.

[16] Note that the U.S. imports very little poultry (table 4.1). The top poultry exporters are the U.S. (2,825,000 mt) Brazil (947,000 mt), Hong Kong (791,000 mt), France (416,000 mt), China (410,000 mt), and Thailand (323,000 mt) (FAS, March 2001). Note that countries may also be transhipment points for international trade (e.g., Hong Kong).

**Table 4.5—Import requirements for poultry and quantities for the top 10 importers of U.S. broilers and for Chile**

| Importing country | Products eligible for import from the U.S.[1] | *Salmonella*-specific regulations/requirements[1] | Imports from US[2] |
|---|---|---|---|
| | | | *Mil. pounds* |
| Hong Kong | Fresh/frozen poultry and poultry products | Products may be subjected to laboratory examination for microbiological contamination and positive-testing shipments refused entry | 1,291 |
| Russia | Poultry and poultry products, excluding consumer-size packages of ground poultry, mechanically deboned poultry, and giblets | Negative *Salmonella* test results must be presented to FSIS veterinarian before export certification can be issued; consignments are ineligible if there are more than 1 (in 5 minimum) positive samples | 986 |
| Latvia | Poultry and poultry products, except mechanically separated and ground products; must be certified as not having been fed material originating from sheep | No separate *Salmonella*-specific requirements | 500 |
| Mexico | Fresh/frozen poultry and poultry products | No separate *Salmonella*-specific requirements | 325 |
| Japan | All domestic poultry, except duckling giblets, coloring agents in raw products, and poultry and poultry products from or passing through Pennsylvania | Japanese Ministry of Health reserves the right to test shipments of ground and mechanically deboned poultry for *Salmonella* and to reject positive-testing shipments | 224 |
| China | Fresh/frozen poultry products | No separate *Salmonella*-specific requirements | 163 |
| Canada | Federally inspected poultry and poultry products, except carcasses, parts, or mechanically separated poultry parts containing kidneys or sex organs | No separate *Salmonella*-specific requirements | 157 |
| Korea | Poultry and poultry products, except those imported into the U.S. from a third country | No separate *Salmonella*-specific requirements | 131 |
| Estonia | Poultry and poultry products | Mechanically deboned poultry product is tested for *Salmonella* at the port of entry; positive-testing shipments will be denied entry | 247 |
| Poland | Fresh/frozen poultry and poultry products and poultry trimmings, except frozen ground and mechanically deboned poultry | No separate *Salmonella*-specific requirements | 98 |
| Chile | Fully cooked and canned products | Cooking and canning requirement effectively means no *Salmonella* | --[3] |

[1] FSIS, 2002.
[2] Economic Research Service, 2002. Average for 1999-2000.
[3] Not listed separately.

duction by over 5 percent (Associated Press, March 18, 1996). High-level negotiations ensued and trade was resumed.

Later in 2002, there was a short-lived Russian ban on U.S. poultry meat exports as Russia cited *Salmonella* and antibiotic use in poultry production. Partly as a result of this 2002 ban, poultry exports from the United States for 2002 dropped by 13 percent, and U.S. poultry exports to Russia dropped by 35 percent. Orden et al. (2002, p. 162), reporting results from a spatial equilibrium model, suggested that an imposition of sanitary restrictions by Russia on U.S. imports of low-value poultry products would be mitigated because there are sufficient arbitrage possibilities in world markets—as long as the restriction is not imposed on other exporters. However, the restriction was imposed on countries other than the United States (e.g., the Netherlands) and there were real impacts on prices for U.S. poultry exporters.

Similarly, poultry trade between other pairs of countries has been interrupted by real or perceived *Salmonella* contamination. For example, in September 1999, McDonald's temporarily suspended poultry sales in Lithuania after Lithuania banned a Polish company's delivery of 1.5 tons of cooked products contaminated with *Salmonella* (Reuters, Sept. 2, 1999).

The United States also has restrictions on poultry meat imports, largely to keep certain animal and/or human diseases out of the country. For example, imports are restricted from regions where Exotic Newcastle Disease is known to exist. In fact, currently only four countries (Canada, Great Britain, France, and Israel) are permitted to export fresh, frozen, and chilled poultry to the United States, although some plants in northern Mexico may also re-export poultry meat of U.S. origin back to the United States after minimal processing (see chapter 3). As a major poultry producer, however, the United States does not and would not be likely to import significant quantities of poultry in the absence of these restrictions (table 4.1).

Responses to breaches in countries' *Salmonella* standards have taken the form of temporary bans with corrective action or refusals of specific contaminated shipments of products. Vertical integration in the U.S. poultry industry protects producers from some risks, but the importance of poultry exports combined with the possibility of new or extensive *Salmonella*-related embargoes, bans, or new zero- or low-tolerance standards poses financial risks for many integrated producers.[17]

## Conclusions From the *Salmonella* Case Study

Many countries have trade restrictions for *Salmonella* and these restrictions vary widely by type (specific products or processing methods), extent (inspections of slaughter facilities, production practices), and duration. Some countries have zero- or low-tolerance standards for *Salmonella* in imported poultry while others reserve the right to test for *Salmonella* or permit imports of cooked or canned products only, which in practice implies a zero-tolerance standard for *Salmonella*. These standards affect international trade in livestock products and could also affect the choice of production technologies used in exporting countries. For example, an exporter may choose not to trade with a country having a zero-tolerance standard if the net gains to trade do not cover the costs of meeting the standard. Despite the permanent standards for *Salmonella*, trade interruptions due to *Salmonella* are mostly shortlived bans against specific products or rejections of specific contaminated shipments. Some countries' import standards are inconsistent with their domestic standards; to avoid running afoul of WTO regulations, such differences need to be based on science or legitimate differences in risk preferences, otherwise they might face allegations that they are being used as trade barriers. Further research is needed to determine whether world poultry trade would be higher if countries were to harmonize around lower standards or vice versa. Also, further research is needed to increase our understanding of the size of food safety diversions relative to total world poultry trade.

# Case Study 3: Concerns about the Potential Trade Impacts from Antibiotic-Resistant *Salmonella*

Another dimension of the potential trade impacts from pathogen-food safety issues, and the focus of this third

[17] The U.S. poultry industry is very different from the U.S. beef industry. Although both poultry and beef production are moving toward fewer and larger producers, poultry operations are currently more integrated, while beef operations remain dispersed among a greater number of smaller independent operations. One cost-reducing benefit of low-level antimicrobial drug feeding is the ability to have greater numbers of livestock at one facility.

case study, is the capacity of many foodborne pathogens, including *Salmonella*, to develop resistance to antimicrobial drugs. This case study discusses three elements of this issue and trade implications: (1) the increasing drug resistance observed in *Salmonella*, (2) the controversy over the extent to which antibiotic drug use in livestock production contributes to the development of drug-resistant pathogens, and (3) the potential for food contamination with drug residues.

## Increasing Drug Resistance

Drug use in livestock is implicated in antimicrobial resistance in humans because many antimicrobial drugs used for livestock are the same as or similar to drugs used for humans. Some pathogens can pass from livestock to humans, either directly through contact (Feinman, 1979; Fey et al., 2000; Holmberg et al., 1984) or through food products that are improperly processed, handled, or prepared. Some foodborne illnesses in humans caused by resistant pathogens have been traced to livestock products (Gashe and Mpuchane, 2000; USDA, 1997; White et al., 2001) and have been linked to live animals on farms (Feinman, 1979; Holmberg et al., 1984; Molbak et al., 1999).

In livestock trade, the importing country not only sets product standards (e.g., the zero tolerances for *Salmonella*), they may also set process standards (e.g., the EU hormone ban) (FAS, 2003). They may also require government verification of the standard which can lead to a virtual ban in two ways—the cost of verification is prohibitive (e.g., hormones), or the government is unable to provide the desired verification and certification (FAS, 2003). While not now directly a trade issue, drug use by livestock could become more of an international trade issue if prohibitions against domestic production technologies in importing countries were expanded to more fully cover imports. For example, Russia and the Ukraine both periodically threaten or impose temporary prohibitions on imports of U.S. poultry products based on drugs or chemicals used in production (e.g., Reuters, Jan. 23, 2002). These prohibitions could mean that exporters who use the implicated antibiotics in animal production would have to sell their products to other countries (perhaps at lower prices), incur higher transportation costs, or destroy contaminated shipments altogether. Data are not readily available on the magnitude of imports diverted because of this issue. To date, no country has proposed formal prohibitions against *therapeutic* uses of livestock drugs (i.e., antibiotic use for treatment of disease), which would have animal welfare implications.

S. Typhimurium (hereafter referred to as Typhimurium) is the type of *Salmonella* most often mentioned in discussions about antibiotic resistance from livestock drug use. Typhimurium strains have caused numerous human illnesses and deaths worldwide. Typhimurium DT-104 is particularly troublesome, with a hospitalization rate double that of other foodborne *Salmonella* infections and a fatality rate 10 times higher (WHO, 1997).

Human illness from DT-104 was first recognized in England and Wales in the 1960s, but resistant DT-104 has been known only since the 1980s (Threlfall, 2000). The first resistant isolates were taken from gulls and exotic birds. The resistance was not isolated from humans until 1989, and was then isolated from cattle over the next 5 years (Threlfall, 2000). It has also been isolated from poultry, swine, other domestic animals, and wild animals (USDA, 1997). DT-104 has been detected mainly in industrialized countries with more concentrated livestock production technologies (e.g., Austria, Canada, Denmark, France, Germany, UK, and the United States) (USDA, 1997).

About 95 percent of DT-104 strains are resistant to ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline (GAO, 1999), antibiotics commonly used to treat human illnesses. Since 1996, UK scientists have also reported resistance to fluoroquinolones (GAO, 1999). This resistance to fluoroquinolones occurs in about 14 percent of DT-104 strains in the UK (GAO, 1999), but is currently rare in the United States (Marano et al., 1999). In the United States alone, there are an estimated 68,000 to 340,000 human illnesses from S. Typhimurium each year with resistance to five antibiotics, and most of these illnesses were probably due to DT-104 (Glynn et al., 1998).

Pathogens affecting livestock and pathogens affecting humans are often of different types or are often present in differing concentrations. For example, while many of the same *Salmonella* serotypes are found in both humans and livestock, the 5 most common types of *Salmonella* in cattle (of 26 serotypes identified) were different from the 5 most common human types identified by the U.S. Centers for Disease Control and Prevention as associated with human illnesses (USDA, 1995). This difference in primary serotypes emphasizes the fact that we do not have a thorough understanding of the epidemiological link between humans and animals.

While some pathogens appear to be widespread in terms of infected U.S. livestock operations and markets, their prevalence in livestock populations appears much lower. The share of animals that tested positive for *Salmonella*, *Escherichia coli*, or other selected bacteria has ranged from 1 to 5 percent, while the number of livestock operations or markets that had at least one positive test has ranged from 10 to 67 percent (USDA, 1995, 1996b, 1998, 2000). The prevalence of drug resistance in bacteria from these samples, however, is not known. While some samples likely contained resistant strains of bacteria, it is unlikely that all samples contained resistant bacteria.

## Livestock Drug Controversy

Some countries (e.g., EU member countries) prohibit the low-level (*subtherapeutic*) use of certain antimicrobial drugs as growth promotants in livestock production. Others have proposed such prohibitions based on policymakers' perception that enough evidence links livestock drug use and human antibiotic effectiveness in treating foodborne illnesses. In the United States, several bills have been introduced to prohibit antibiotics from at least some uses in animal agriculture (e.g., H.R. 3266 on Nov. 9, 1999, H.R. 3804 on Feb. 27, 2002, S. 2508 on May 13, 2002, and S.1460 and H.R. 2932, both on July 25, 2003). In June 2000, the WHO adopted a statement of principles proposing that use of antimicrobial livestock drugs to promote growth be terminated. In June 2001, the EU prohibited all but four antimicrobial drugs used as growth promotants in livestock production (Mathews et al., 2001). The four remaining drugs will be phased out by 2006 (European Council, 2002).

## Livestock Drug Residues

A related issue concerning antibiotic drug use in livestock pertains to antibiotic drug residues that are considered unsafe yet remain in some internationally traded animal products (see box 4.4). Some importing countries have refused entry to shipments testing positive for these drug residues. Others have invoked temporary bans on shipments from specified countries. For example, the EU's veterinary committee recommended that the EU suspend imports of some meats and seafood from China because of antimicrobial drug residues in farm-raised shrimp and prawns (Reuters, 1/28/02).[18]

The EU has prohibited the subtherapeutic use of some antimicrobial drugs in livestock production and other countries have proposed such prohibitions because of their concerns about possible effects on resistance in foodborne pathogens. These restrictions could extend to antimicrobial drug use in livestock production by exporting countries and could also force changes in production technologies. A concern of the United States is the science base for these and other food regulations. Countries vary in what they accept as sound science, which is particularly important in risk assessments.

# Conclusion

Increased urbanization, increasing populations, and rising incomes have increased per capita demand for meat, milk, and eggs worldwide. The increased demand for high-quality protein to improve children's growth, cognitive development, and health has also contributed to increased global demand for meat and poultry. Concerns about food safety hazards in meat and poultry have motivated public and private efforts to ensure safer food and to protect markets, both domestically and internationally. These food safety hazards are particularly worrisome if they make a large number of people ill worldwide (e.g., *Salmonella*) or if they are particularly virulent (e.g., BSE).

Public sector responses have ranged from position statements (WHO, FAO, and OIE) to regulations affecting imports and exports, such as minimum standards for pathogen, chemical, and residue contaminants in imported food products. The regulations related to these standards range from rejection of specific shipments (e.g., for *Salmonella*) to longer term bans against all potentially contaminated products (e.g., against imports of live cattle from the UK because of BSE concerns). Food safety standards and regulations vary by country but are evolving in response to the WTO principles, emerging food safety incidents and risks, and new technology.

Impacts and regulations often extend beyond the sectors directly affected by a food safety issue. For example, BSE has affected the rendering industry and feed,

[18] The United States has embargoed shipments of aquacultural products contaminated with chloramphenicol.

## Box 4.4—Antibiotic Residues

Drugs administered to livestock can affect human health and food safety through drug residues in food products. Small amounts of such residues have been deemed safe for human consumption worldwide by the Food and Agriculture Organization (FAO) and the Food and Drug Administration (FDA). The FDA, for example, established 1.5 milligrams per person per day as the acceptable daily intake (ADI) of noncarcinogens. For antimicrobial drugs, this is a level that should produce no effects on the human intestinal bacteria. Other antimicrobial drugs have not been approved for use in livestock production or have been outlawed.

Residues from some antibiotics are considered unsafe at any level. FDA has not established ADIs for these drugs. For example, chloramphenicol is still used occasionally to treat diseases in aquacultural operations in China, India, Indonesia, Malaysia, Thailand, and Vietnam, all of which are major exporters of shrimp. Its use has declined in these areas as information reaches farmers about its toxicity—it has caused leukemia and can cause genetic damage, possibly leading to cancer. The chemical has, however, found its way into livestock feeds and livestock products in Europe.

Developing new drugs is expensive. Drug manufacturers and sellers must abide by increasingly stringent and time-consuming regulations and legislation when developing new drugs for use on either humans or animals. The Animal Health Institute estimates that only 1 in 20,000 discovered chemicals becomes available for farm use. Approval of a new drug can take a decade or longer.

***Major legislation affecting animal drug use and residue levels since 1989:***

**Nutrition, Labeling, and Education Act of 1990**—Pre-empts State requirements about food standards, nutrition labeling, and health claims.

**Animal Medicinal Drug Use Clarification Act of 1994**—Allows licensed veterinarians to prescribe human drugs for use in animals under certain conditions.

**Animal Drug Availability Act of 1996**—Adds flexibility to animal drug approval process.

**Food and Drug Administration Modernization Act of 1997**—Regulates advertising of unapproved uses of approved drugs.

gelatin, cosmetic, pharmaceutical, and medical sectors. In many countries, new rules and regulations for feedstuffs have been put in place to allay public sector concerns over BSE and food safety threats such as vCJD. But new regulations to solve one food safety problem can create new trade challenges. For example, higher EU standards for gelatin are currently blocking U.S. gelatin exports to the EU even though BSE has never been identified in the United States. Countries worldwide, with and without endemic BSE, are affected by the crisis both in terms of market access for exports and new, targeted restrictions for imports.

International food safety standards concerning *Salmonella* and poultry vary by type (specific products or processing), extent (inspections of slaughter facilities, production practices), and duration. These bans usually pertain to contaminated shipments, but governments may also impose temporary bans against specific products from specific producers or countries. Meanwhile, production and process standards can extend to drugs administered to livestock even when residues have not been identified as a problem (e.g., threatened Russian ban against poultry) and in part, because of concerns that some pathogens, such as *Salmonella*, can develop resistance to drugs meant to kill them.

This variety in standards is one example of national sovereignty where each WTO member has the right to determine its own level of SPS protection. Part of the diversity in standards may reflect differences in the science base among countries. Two challenges related to *Salmonella* facing international bodies are how to handle "zero-tolerance" standards when science suggests that zero risk is infeasible, and how to ensure that any differences between standards for domestic and imported products are based on science or legitimate differences in risk and are not simply trade barriers in disguise.

In addition to public sector approaches, private approaches to reduce food safety risks are becoming more widespread and stringent (Caswell and Henson, 1997) and are helping firms improve their international competitive positions in cases where the products are perceived to be safer. Private sector approaches for meat and poultry include self-regulation, vertical integration (to ensure quality/safety of inputs and traceability, for example), voluntary or mandatory HACCP systems, and third-party certification such as the International Organization for Standardization. For example, in the United States, McDonald's has imposed antibiotic restrictions on its livestock suppliers (Lipsky, 2003), even though the U.S. government does not believe this is necessary (FAS, 2003). Effective implementation of such private sector approaches is key to enhancing food safety, in tandem with public approaches (e.g., country-of-origin labeling). Some of these private responses may have supply implications for exporting countries.

Many producer groups have voluntarily developed guidelines for their members aimed at enhancing the safety of their commodities.[19] These "Quality Assurance Programs" are designed to ensure wholesome livestock products. They include elements aimed at reducing pathogens and at properly using pharmaceuticals (Committee on Drug Use in Food Animals, 1998). Other private organizations that have adopted guidelines for antimicrobial drug use include the American Veterinary Medical Association, American Association of Bovine Practitioners, and American Association of Swine Practitioners (USDA, 1999). Several U.S. producers have also reduced or plan to reduce their use of certain antibiotics to ease consumers' fears (Burros, 2002; Kilman, 2002). For example, several U.S. poultry producers have begun withdrawing their use of the fluoroquinolone drug Baytril.

Some ongoing meat and poultry disputes have highlighted the difficulty in separating actions designed to ensure food safety of imported food products from actions to erect trade barriers using SPS standards as the justification. For example, Russia restricted or threatened to restrict poultry imports several times over the past decade, justified in part by its zero tolerance for *Salmonella* contamination and the use of certain antibiotics in U.S. poultry production that are not registered in Russia. Even after the United States made changes to meet Russian demands, Russia imposed import tariffs and quotas in 2003. These restrictions and tariffs are crucial in terms of trade because Russia is the world's largest importer of broilers (FAS, 3/11/02). Ukraine continues to ban U.S. poultry even after a protocol was negotiated that met its concerns (FAS, 2003).

The twin goals of ensuring food safety and protecting trade can be enhanced through transparent and immediate public responses to food safety crises, as well as up-to-date prevention and monitoring efforts. Transparent and immediate public response to food safety crises is necessary to protect consumer confidence in the food supply and in the government (Pickelsimer and Wahl, 2002). For example, consumer confidence in the UK declined in 1996 when the British government reversed its previous position that BSE was not related to human illnesses. Given emerging food safety issues and the spread of known problems to new regions (e.g., spread of BSE to Japan and Canada), it is increasingly important for policymakers to anticipate foodborne hazards and, if these hazards materialize, to launch control measures that mitigate their effects on human health, animal health, and international trade. Ideally, actions should be commensurate with the food safety risks to human and animal health.

[19] The Committee on Drug Use in Food Animals (1998) provides examples of these producer groups, which include the National Pork Producers Council, National Cattlemen's Beef Association, National Milk Producers Federation, American Sheep Industry Association, American Veal Association, National Broiler Council, National Turkey Federation, United Egg Producers, Catfish Farmers of America, National Aquaculture Association, and U.S. Trout Farmers Association.

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*Chapter 5*

# Produce, Food Safety, and International Trade

## Response to U.S. Foodborne Illness Outbreaks Associated with Imported Produce

Linda Calvin[1]


### Summary

Outbreaks of foodborne illness in the United States associated with imports of fresh produce affect not only consumers and the growers of the contaminated product, but also frequently other suppliers to the U.S. market, including U.S. producers. Because most produce is highly perishable, the United States depends on seasonal imports for a year-round supply of some items. Often by the time someone falls ill from an imported product and an investigation identifies both the product and its origin, that country may no longer be exporting the product to the United States. For example, a foreign grower may just supply the United States for a brief market window before the U.S. season begins. Of course, many foreign suppliers have much longer seasons. The negative publicity about an outbreak will often affect whichever suppliers are selling their product at that time—often U.S. producers—whether they had anything to do with the outbreak or not.

The impact of a foodborne illness outbreak on trade depends on whether foreign producers can quickly correct the contamination problem and convince buyers that their product no longer poses a risk. This chapter reviews outbreaks of foodborne illnesses associated with Guatemalan raspberries, Mexican strawberries (contaminated either in Mexico or the United States), and Mexican cantaloupe. In the Mexican strawberry case, after just one outbreak and an initial collapse of trade, strawberry trade rebounded in the following years. In the Guatemalan raspberry and Mexican cantaloupe cases, the U.S. Food and Drug Administration (FDA) refused to accept these products into the United States after outbreaks in consecutive years. The Guatemalan raspberry industry has never really recovered from the experience although it is now free to ship to the United States under a rigorous food safety program. The impact of the ongoing cantaloupe problem on future trade is still unknown.

FDA, the Centers for Disease Control and Prevention, the produce industry, retailers, and foreign governments have worked together to keep unsafe produce off the market and resolve food safety problems. The FDA's voluntary guidelines for good agricultural practices (GAPs) provide recommendations to growers, both domestic and foreign, on how to reduce microbial hazards. FDA emphasizes that GAPs only reduce the risk of microbial contamination and cannot eliminate the risk. If invited by a foreign government, FDA will often visit an area associated with an outbreak to try to identify practices that are inconsistent with GAP guidelines. FDA also provides training in foreign countries on GAPs.

Many individual growers have responded to increased concern about foodborne illnesses (and attendant financial losses) by improving their food safety systems. Grower organizations have been instrumental in developing better food safety and traceback systems to protect the reputation of their particular crops. While individual farmers might not want a contamination problem traced to their operation, the industry as a whole is more concerned with accountability. Retailers, who face unwanted publicity in a foodborne illness outbreak, have also taken the initiative by demanding more stringent food safety programs from their suppliers. Some demand that their produce suppliers have third-party audits to verify that they are complying with GAP guidelines.


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## Introduction

The U.S. food supply is one of the safest in the world (Crutchfield and Roberts, 2000). In the mid-1990s, however, outbreaks of foodborne illnesses linked to microbial contamination of both domestic and imported produce focused attention on the potential for contamination at the grower and shipper level (Tauxe, 1997).[2] For example, in 1996 the potentially dangerous bacterium *Escherichia coli* O157:H7 was linked to California lettuce associated with farm-level contamination. In the same year, a very large foodborne illness outbreak was linked to imported Guatemalan raspberries contaminated at the farm level with the parasite *Cyclospora*. The economic impacts of outbreaks made it clear to the produce industry, particularly those sectors associated with contaminated produce, that improved food safety programs were necessary. The U.S. government also became more involved in produce food safety at the farm and shipper level.

In the United States, responsibility for food safety of imported foods resides with USDA's Food Safety and Inspection Service (FSIS) and the U.S. Food and Drug Administration (FDA). FSIS deals with meat, poultry, and some egg products, and FDA covers all other food products, including produce. Both agencies require imported foods to meet domestic food standards. FSIS allows only imports from countries with food safety systems it deems to be equivalent to those in the United States, thus putting the burden for safety on the exporting country. Unlike FSIS, FDA does not have legal authority to require that imports of the products it covers be produced with food systems equivalent to those in the United States.

Food safety concerns can focus on pesticide residues, microbial and chemical contamination, and the effects of biotechnology. FDA randomly tests both imported and domestic produce for pesticide residues. FDA also randomly tests chemical residues, although this testing is much more limited in scope. Concern about microbial contamination is relatively new. Biotechnology, an important determinant of trade flows for other agricultural products, is not yet a central concern for fruit and vegetables. Traditionally, FDA has relied on inspections at the port of entry to ensure safety of the products. While this worked well for food safety issues such as detecting pesticide residues exceeding U.S. tolerance levels, testing for microbial contamination is a completely different challenge. The FDA tolerance for microbial pathogens is zero, so it would deny entry to any produce with contamination that could be detected, but testing for microbial contamination is not very successful. Microbial contamination is often low level and sporadic so it can be difficult to detect. Also, if perishable produce is held at the border while microbial tests are completed, it may deteriorate in quality to the point where it cannot be sold. In comparison, if produce has pesticide residues that exceed the legal tolerance, it is likely to be pervasive and contamination would show up in random testing. FDA does targeted sampling for microbial contamination when there are concerns about a specific product.

In 1997, President Clinton announced the Produce and Imported Food Safety Initiative, which called for additional resources to improve domestic standards and to ensure that imports were equally safe (Crutchfield, 1999). Three broad areas of action were identified. First, the President directed FDA to seek new legal authority to require equivalence in food safety systems in foreign countries (but there has been no change in legislation). Second, the initiative targeted more resources at improving inspection activities abroad by providing technical assistance. This has been an important means of improving food safety abroad. Third, the initiative focused on providing guidance to both domestic and foreign producers on good agricultural practices (GAPs).

In 1998, FDA published voluntary guidelines for both domestic and foreign producers on GAPs for reducing microbial contamination (FDA, 1998). Although voluntary, GAPs are now an important part of the produce industry. FDA does not have mandatory food safety requirements with respect to microbial contamination for the fresh produce industry. This situation provides incentives to the produce industry to voluntarily adopt GAPs and ensure that food safety does not become a bigger issue. FDA and the produce industry have developed a good working relationship and have made important improvements in food safety. FDA could impose mandatory food safety standards for fresh produce if deemed appropriate. For example, in the late 1990s, there were three foodborne illness outbreaks associ-

[2] Shippers are the first marketers in the produce distribution chain and are often involved with harvesting and packing produce, a stage at which contamination may occur. Many shippers are vertically integrated grower-shippers.

ated with fruit juice—one *E. coli* O157:H7 outbreak associated with apple juice and two *Salmonella* outbreaks associated with orange juice. Two people died. In 2001, FDA published a final rule requiring juice processors to use hazard analysis and critical control point (HACCP) principles (FDA, 2001b). FDA also requires HACCP for seafood processors. These mandatory requirements also apply to imported products.

FDA promotes adoption of GAPs as a means to minimize microbial contamination, instead of relying on relatively ineffective testing at the border to detect problem produce. According to FDA, even with GAPs it is not possible to eliminate microbial contamination for produce although it is possible to reduce the risk. For fresh and fresh-cut produce, there is no effective microbial elimination step such as pasteurization for milk.

GAPs provide growers with a structure to evaluate different practices and their potential to reduce microbial food safety hazards so they can develop a food safety program tailored to their own operations (see box 5.1). Many grower practices—such as water sampling or worker hygiene programs—could reduce the risk of microbial contamination. Each grower must evaluate the benefits and costs of investing in risk-reducing practices. This assessment will vary by crop, environmental conditions, and individual grower situation.

It is not always clear how much additional investment in food safety practices is enough. A foodborne illness outbreak may occur if a farmer cuts corners and fails to adopt a practice considered standard in the local industry. Other outbreaks may represent cases where growers and scientists misjudge what is required to prevent problems and growers underinvest in food safety practices. The science and tools available to growers to reduce the risk of contamination are still evolving. Of course, with uncertainty, growers may also overinvest in food safety precautions. There is always the concern that a practice may be a technical but not an economic success. Some segments of the produce industry are undoubtedly more advanced than others in their efforts to reduce these risks, but there is no systematic survey of growers to identify their progress.

This chapter examines one aspect of the food safety issue, the private and public responses to U.S. foodborne illness outbreaks due to microbial contamination associated with imported produce.[3] Even when the contaminated product is imported, the U.S. industry is often affected and both domestic and foreign growers need to take action to protect their economic well being. The chapter begins with information on microbial contamination of produce and the role of produce imports in U.S. consumption. Three examples of foodborne disease outbreaks follow which demonstrate how growers, grower organizations, governments in the United States and abroad, and retailers responded to contamination problems. The analysis also includes a brief look at the impact of contaminated imports on trade. The three examples are: (1) imports of Guatemalan raspberries associated with *Cyclospora*, (2) imports of Mexican strawberries associated with hepatitis A (contaminated either in Mexico or the United States), and (3) imports of cantaloupe from Mexico associated with *Salmonella*.[4] In each case, the contamination occurred, or may have occurred, at the grower or shipper level. Then the analysis turns to a comparison of the private and public responses to food safety problems demonstrated by the three case studies. Concluding comments focus on lessons learned and areas for future research.

## Foodborne Illness Outbreaks

Despite heightened concern about food safety, the vast majority of growers for the U.S. market, both domestic and foreign, has never been involved in food safety

[3] This study does not examine pesticide residue contamination. A study of U.S. winter vegetable imports from Mexico showed that pesticide residue violations were relatively infrequent (Calvin and Barrios, 1998). In 1997, FDA tested 3 percent of total shipments through Nogales, Arizona, and only about 3 percent of the tested products were in violation of pesticide residue standards. Of the winter vegetables—tomatoes, bell peppers, cucumbers, eggplant, summer-type squash, and snap beans—only snap beans had any violations. Of course, the winter vegetable industry in Mexico is well established. When Guatemala began exporting snow peas, a nontraditional export, in the late 1980s, it had a serious problem with pesticide residues that took several years to control. A program to pretest shipments in Guatemala to ensure they would pass FDA inspections finally resolved the problem.

[4] *Cyclospora* is a protozoan parasite that causes cyclosporiasis, a potentially debilitating diarrhea that can last for three weeks or more. The disease is treatable and is only considered potentially life threatening to those with compromised immune systems. The hepatitis A virus causes liver disease. The bacterium *Salmonella* causes salmonellosis, which is characterized by diarrhea, fever, and abdominal cramps. Most people recover without treatment but it can cause death in some cases when the infection spreads beyond the intestines.

## Box 5.1—Microbial Contamination and FDA's Good Agricultural Practices (GAPs)

There are many sources of potential microbial contamination for produce and some regions will face more challenges than others. Some of the major sources at the grower and shipper level include: soil, water, green or inadequately composted manure, dust in the air, wild and domestic animals, human handling, and contaminated equipment (FDA, 2001e). Sources of water contamination include water used for irrigating, mixing with pesticides, washing and rinsing produce, and making ice to cool produce. Different food safety practices can mitigate the chances of contamination. Other factors unique to specific plants also affect the probability of contamination.

Good agricultural practices (GAP) principles provide growers with guidelines to reduce the potential for microbial contamination of their products. Guidelines cover growing, harvesting, sorting, packing, and storage operations. National-level guidelines on GAPs enhance the consistency and scientific basis of food safety programs developed by public and private institutions. Using GAPs reduces but does not eliminate all risk—an unobtainable goal with current technologies.

Growers and shippers are directed to evaluate their operations in terms of water quality; manure/municipal biosolids; worker hygiene; field, facility, and transport sanitation; and traceback capabilities. Traceback is the ability to track food from the consumer point of purchase back to the grower. Recommended practices are provided to mediate each risk. Since there are numerous potential ways to reduce risk, FDA encourages growers to pick the most cost-effective combination of practices. Therefore, two growers in different areas with different environmental conditions could both adhere to GAP principles but use different methods to do so.

GAP guidelines do not outline specific testing and monitoring regimes because scientific data is lacking for establishing more specific guidelines (FDA, 2001e). The GAP guidelines state "Water quality should be adequate for its intended use. Where water quality is unknown or cannot be controlled, growers should use other good agricultural practices to minimize the risk of contamination." The guidelines do not specify how to measure whether water quality is adequate; no one knows for sure and what is adequate varies by crop. For example, irrigation water for a crop that matures on the ground may need to be cleaner than water for an orchard crop.

Use of the GAP guidelines can be broken down into three stages. First, growers and shippers can use GAPs to evaluate their food safety system and assess needs. Some large firms with food safety staff may evaluate their own systems. Some smaller growers might hire a third-party audit firm to do an evaluation. FDA does not regulate third-party audit firms. In 2001, a FDA report estimated the cost of an evaluation at $300-$500 per farm (FDA, 2001e). An evaluation would include a review of the current food safety system and an assessment of what additional practices might be needed to reduce the chance of contamination, including the documentation necessary to assure continuous compliance with GAPs.

Once growers have a food safety system evaluation and needs assessment, they may decide to adopt new practices to reduce risks. The cost of implementation depends on the particular crop, the existing food safety system, and the environment in which the growers operate (e.g., some areas may have more water contamination problems to contend with than others). Some typical practices that a farmer might adopt could include: water testing; water treatment programs; development of a documentation system to corroborate practices and trace product; and provision of additional hygiene facilities for workers.

Growers may opt to have their food safety program audited periodically by third-party audit firms. Some retailers now require third-party audits to verify that growers and shippers are in compliance with GAPs. In 2001, FDA estimated the typical cost of an audit to be similar to the cost of an evaluation, about $300-$500 per farm (FDA, 2001e).

outbreaks. It is difficult to assess the exact incidence of foodborne outbreaks associated with produce and how it has changed over time. The Centers for Disease Control and Prevention (CDC) collect data on all reported foodborne outbreaks. The average annual number of foodborne illness outbreaks associated with fresh produce, both domestic and imported, more than doubled between 1973-87 and 1988-91, from 4 per year to 10 (Tauxe et al., 1997). The increasing trend appears to have continued through 1997 (Sivapalasingam, 2002). More recent data are not yet available.

What does this trend indicate? The data are incomplete so it is difficult to generalize about food safety outbreaks beyond saying the number reported has increased. Researchers assume that most sporadic cases and many outbreaks of foodborne diseases are unreported since a case cannot be reported unless individuals seek medical care. Many outbreaks are never definitively linked to a particular contaminated product or source. In the case of perishable fruit and vegetables, by the time the authorities begin to investigate, the physical evidence has usually been consumed or discarded. As a result, it is not possible to say anything authoritative about the incidence of contamination for various types of fruit and vegetables. It is also not possible to say whether imported produce is any more prone to food safety problems than is domestic produce (Zepp et al., 1998).

The data also include outbreaks associated with contamination at all levels. Produce can be contaminated at the grower or shipper level, at some intermediate level of the distribution system, or at the final point of service (retail store, foodservice establishment, or private residence, etc.). Data are limited and inconclusive regarding what percent of outbreaks are attributable to contamination at the grower or shipper level compared with other points along the distribution chain, or whether contamination at any one level is increasing.

Efforts are underway to further investigate the incidence of food safety problems in produce. As part of the Produce and Imported Food Safety Initiative, USDA's Agricultural Marketing Service (AMS) is implementing the Microbiological Data Program, a nonregulatory program that will provide baseline information on microbial contamination of produce. A select group of produce items, both domestic and imported, are being tested for pathogenic *E. coli* and *Salmonella* (AMS, 2001). There is industry concern, however, that since USDA is testing at terminal markets and chain store distribution centers, it will not be clear where any detected contamination occurred (*Produce News*, 2002). A problem might be mistakenly attributed to the farm level when it could have occurred somewhere else along the distribution chain. On the other hand, a finding of no contamination at the terminal market and chain store distribution center level would shift concern towards problems at the final point of service.

For the Produce and Imported Food Safety Initiative, FDA collected data on the incidence and extent of pathogen contamination (FDA, 2001a). Beginning in March 1999, FDA tested domestic and imported produce items for three microbial pathogens—*Salmonella*, *Shigella*, and *E. coli* O157:H7.[5,6] *Salmonella* and *Shigella* were both found in imports and domestic products, but no *E. coli* O157:H7 was found in either. The focus of these studies was to identify problems resulting from failures to implement adequate GAPs and good manufacturing practices (GMPs).[7] The testing program was not intended to determine whether imported or domestic produce is more prone to safety problems since the statistical properties of the samples did not allow broad conclusions about general food safety of produce or comparisons between countries.

Policymakers and researchers are concerned about why reported food safety outbreaks associated with produce are increasing. Better reporting due to improved outbreak investigations and better diagnostics have undoubtedly contributed to some of the increase (FDA, 2001e). Some scientists, however, do not believe that better reporting alone explains the increased level of outbreaks (Tauxe et al., 1997). It is difficult to sort out the competing factors.

[5] The *Shigella* bacteria causes shigellosis, an infectious disease characterized by diarrhea, fever, and stomach cramps. People with severe cases can usually be treated with antibiotics. Those with milder cases will usually recover without antibiotics.

[6] For the imported produce survey, FDA sampled broccoli, cantaloupe, celery, cilantro, culantro, loose-leaf lettuce, parsley, scallions, strawberries, and tomatoes from 21 countries. The crops were selected based on a combination of five factors that contributed to overall food safety risk: previous association with outbreaks, structural characteristics that might provide a particularly hospitable environment for bacteria, growing conditions, degree of processing, and importance in U.S. consumption (FDA, 2001a).

[7] GMPs are FDA regulations for food processors. FDA recommends firms packing raw, intact fruit and vegetables use GMPs, but they are not required to do so. Firms packing fresh-cut products, like bagged salads, are required to use GMPs.

One explanation for increased foodborne illnesses is new and emerging pathogens. Several outbreaks in the 1990s were due to these pathogens, and scientists had to develop new practices to avoid contamination. The microbial pathogen *E. coli* O157:H7 was identified in 1982 and was initially associated with ground hamburger.[8] In the early 1990s, *E. coli* O157:H7 was first associated with a number of produce items. The parasite *Cyclospora* was described definitively only in 1994 and has been linked to numerous outbreaks since. *Cyclospora* has only been associated with a few products—raspberries, basil, and lettuce—although many cases could not be traced to a particular product.

Another potential explanatory factor behind the rise in outbreaks attributed to produce is the change in U.S. consumption habits. U.S. per capita consumption of fresh fruit and vegetables (not including juices and other processed products) increased from 249 pounds in 1981 to 339 pounds in 2000, an increase of 36 percent. The types of food consumed have also changed. The typical grocery store carried 345 produce items in 1998, compared with 173 in 1987 (Calvin et al., 2001).

Retailers now routinely provide produce items that were once considered seasonal on a year-round basis. Most produce is highly perishable and cannot be stored to provide a year-round supply, so imports are important. However, even storable produce is sometimes imported; apple imports provide consumers with different varieties and qualities (e.g., fresh-harvest apples from Southern Hemisphere countries during the spring versus stored apples). In 2000, imports accounted for 19.5 percent of fresh fruit consumption (excluding bananas), up from 3.1 percent in 1975.[9] Similarly, in 2000, imports accounted for 13.6 percent of fresh vegetable consumption (excluding fresh potatoes), up from 5.7 percent in 1975 (table 5.1).

Bananas top the list of per capita fruit consumption in the United States, with imports accounting for 99.6 percent of consumption. Likewise, 76.1 percent of pineapples, another tropical product, are imported. For a storable crop like apples, imports are 7.2 percent of consumption. For grapes, which are now available every month of the year, the import share increased from 5.9 percent in 1975 to 44.1 percent in 2000. For the vegetable and melon category, 37.4 percent of cantaloupe consumption was imported in 2000, up from 12.4 percent in 1975. Less than 1 percent of lettuce is imported because it can be produced year-round domestically. Tomatoes, bell peppers, and cucumbers have high import shares due largely to winter imports from Mexico and increasing greenhouse imports, particularly from Canada.

There is no reason, however, to assume that imports are more prone to food safety problems than domestic

**Table 5.1—Fresh fruit and vegetable consumption and imports**

| Item | Per capita consumption | | Imported share of consumption | |
|---|---|---|---|---|
| | 2000 | 1975 | 2000 | 1975 |
| | *— Pounds farm weight —* | | *— Percent —* | |
| **Fruit:**[1] | | | | |
| Bananas | 28.4 | 17.6 | 99.6 | 99.9 |
| Apples | 17.4 | 19.5 | 7.2 | 2.2 |
| Oranges | 11.7 | 15.9 | 8.5 | 0.8 |
| Grapes | 7.3 | 3.6 | 44.1 | 5.9 |
| Peaches | 5.5 | 5.0 | 6.4 | 0.3 |
| Grapefruit | 5.1 | 8.4 | 3.0 | 0.6 |
| Strawberries | 5.0 | 1.8 | 5.8 | 8.9 |
| Pears | 3.2 | 2.7 | 20.6 | 3.5 |
| Pineapples | 3.2 | 1.0 | 76.1 | 48.0 |
| Tangerines | 2.8 | 2.6 | 25.7 | 9.5 |
| **Vegetables and melons:**[2] | | | | |
| Potatoes | 47.2 | 52.6 | 5.7 | 1.2 |
| All lettuce | 32.0 | 23.5 | 0.7 | 0.0 |
| Onions | 18.3 | 10.5 | 9.3 | 4.0 |
| Tomatoes | 17.6 | 12.0 | 32.9 | 21.9 |
| Watermelon | 13.9 | 11.4 | 11.5 | 5.9 |
| Cantaloupe | 10.8 | 5.2 | 37.4 | 12.4 |
| Carrots | 10.4 | 6.4 | 5.5 | 4.4 |
| Sweet corn | 9.2 | 7.8 | 2.1 | 0.0 |
| Cabbage | 9.1 | 8.9 | 3.5 | 0.3 |
| Bell peppers | 7.0 | 2.5 | 19.6 | 12.6 |
| Cucumbers | 6.4 | 2.8 | 41.4 | 21.6 |
| Broccoli | 6.0 | 1.0 | 6.3 | 0.0 |

[1] For citrus, the year reflects the end of the harvest; for noncitrus, the beginning of the harvest.
[2] ERS traditionally reports melons with vegetables. Consumption is on a calendar-year basis.

Source: *Fruit and Tree Nut Yearbook*, and *Vegetable and Specialties Yearbook,* ERS, USDA.

[8] One of hundreds of strains of the *E. coli* bacterium, *E. coli* O157:H7 produces a powerful toxin that can cause severe illness. Infection often produces bloody diarrhea, but most people recover without antibiotics or other specific treatment. Some people, particularly children and the elderly, may develop hemolytic uremic syndrome, a life-threatening disease that causes kidney failure.

[9] Data are not true consumption data from consumer surveys but rather disappearance data (production for the fresh market plus imports and minus exports equals disappearance—a proxy for consumption).

produce. Many growers in foreign countries specialize in exports. For example, in the Mexican winter vegetable industry, growers are producing to comply with relevant U.S. government standards (pesticide residues, microbial contamination, etc.) as well as demands of their U.S. marketer and final buyers such as a particular retail chain. Growers are well aware of the food safety requirements. If prices are favorable, they may sell some of their production to the domestic Mexican market but produce grown in Mexico for the domestic market could not easily be sold into the U.S. market.

Much of the U.S. and foreign produce industry has developed a global focus. A network of business relationships tie domestic and foreign producers and encourage high standards of food safety (see box 5.2).

However, with improvements in communications, storage technology, and transportation, it is possible to acquire commodities from many new areas. In recent years, imports have arrived from many nontraditional suppliers. The Caribbean Basin Initiative and the Andean Trade Preference Act have eliminated tariffs on many agricultural items and encouraged imports from these areas. The share of total volume of fresh produce imports (excluding bananas) from three traditional suppliers—Mexico, Chile, and Canada—dropped from 81 percent in 1990 to 72 percent in 2000. Less traditional suppliers have increased their market share of imports. For example, in 1990 only 10 percent of asparagus imports came from Peru, compared with 47 percent in 2001. Similarly, Costa Rica and Guatemala accounted for 17 percent of cantaloupe imports in 1990 and 60 percent in 2001.

Another consumption trend that may affect outbreaks is the growing share of food eaten at foodservice establishments, potentially increasing the number of people handling produce before it is eaten (and the chance of contamination). In 2001, 47.4 percent of total food expenditures went to the foodservice sector, up from 33.4 percent in 1970 (ERS, 2002).

## Three Examples of Foodborne Illness Outbreaks Associated With Imports

Three case studies examine recent food safety problems: (1) disease outbreaks due to *Cyclospora* contamination of Guatemalan raspberries, which began in 1996, (2) the 1997 outbreak of hepatitis A associated with strawberries from Mexico, and (3) the 2000-2002 outbreaks due to *Salmonella* contamination associated with Mexican cantaloupe. By coincidence, all three cases deal with fruit but this does not imply that vegetables are not also associated with foodborne illnesses.

### Raspberries and *Cyclospora*

In the spring and early summer of 1996, CDC and Health Canada received reports of more than 1,465 cases of foodborne illness due to *Cyclospora* in the United States and Canada (for more details on the raspberry case, see Calvin et al., 2002). There were no fatalities. This was a very large outbreak compared to others associated with fresh produce. On June 8, 1996, the Texas Department of Health issued a health warning that erroneously identified the source of the problem as California strawberries, then at peak production. On July 18, 1996, the CDC and the Ontario Ministry of Health issued a statement reporting that Guatemalan raspberries were the most likely source of the outbreaks. The California Strawberry Commission estimated that this false alarm led to $16 million in lost revenue to growers in the central coast of California during the month of June (Mishen, 1996).

By the time raspberries were identified as the source of contamination, the Guatemalan raspberry spring season was over so no immediate regulatory action was taken. FDA and CDC sent a team of investigators to Guatemala later that year to observe growing conditions and to better understand the berry industry there. Because the disease was relatively new to scientists, no one knew which raspberries were contaminated, how they became contaminated, or how to solve the problem. The CDC concluded, after considering the many differences in various aspects of the distribution systems for the implicated raspberries, that simultaneous and persistent contamination on multiple farms was the most likely explanation for the outbreak (Herwaldt et al., 1997). Subsequent research, based on the events for which well-documented traceback data were available, indicated that the 1996 outbreak could have been accounted for by as few as six farms (Herwaldt et al., 1999). Traceback is the ability to track food from the consumer point of purchase back to the grower. FDA provided advice/technical assistance and suggested using GAPs (then under development), GMPs, and sanitation standard operating procedures.

## Box 5.2—Ties That Bind the Domestic and Foreign Produce Industry

A firm importing produce into the United States to supply the offseason market will want a product that is equal in quality to their own to maintain their reputation. This takes planning. The pressure to coordinate year-round production, often in far-flung locations, and provide food safety assurances may favor both horizontal and vertical integration or coordination (Wilson et al., 1997; Hennessey, 1996). For example, a U.S. grower-shipper may decide to collaborate with a foreign grower-shipper to provide a year round supply with particular characteristics—horizontal integration or coordination. A U.S. shipper may decide to collaborate with a foreign grower for the same reason—vertical integration or coordination.

U.S. firms have many types of interests in foreign production to expand their season. For the U.S. firm, it is important that the foreign product be consistent with the quality their firm sells from domestic sources. For example, a U.S. firm may grow product on its own farms in a foreign country for sale in the U.S. market. A U.S. firm might also have a joint venture with a firm in a foreign country to produce a crop to be sold in the United States. In some cases, U.S. firms may merge with a foreign supplier. Many U.S. shippers and grower-shippers also market for foreign growers and charge a sales commission. Some U.S. grower cooperatives have foreign members who must meet domestic production standards

These suppliers must develop relationships with reliable foreign growers to provide these products. Suppliers may travel frequently to foreign production regions to cement the relationship with their growers. The suppliers may send agronomists to check on production and crop conditions. Some even have staff living in foreign countries. The stakes are high when procuring product from another country. In any of these situations, if the product has food safety problems and cannot be sold, the U.S. supplier may not have adequate supplies for its customers, a serious problem in the competitive produce industry. On the other hand, selling a substandard product may damage the firm's reputation if a foodborne illness outbreak is traced back to the firm. The stakes are also high for the foreign producer too. Many foreign countries have very specialized produce industries geared almost exclusively towards exports. If products are not acceptable in the U.S. market they often have few alternative markets. For example, some of the products grown in Mexico for export to the U.S. market, such as bell peppers, cherry tomatoes, and eggplant, have virtually no alternative domestic market.

Large foreign suppliers are following the same trend in horizontal and vertical integration in reverse. For example, some large Mexican and Chilean winter suppliers are expanding into production or joint ventures in the United States and other countries to provide a year-round supply for their U.S. buyers. Foreign growers have also vertically integrated by acquiring marketing operations in the United States. This provides foreign growers with the ability to better market fruit and vegetables since they directly control the quality of their production. For example, many of the shippers located in Nogales, Arizona, where winter vegetables from Mexico enter the United States, are really just the marketing arms of large Mexican growers. In the 1996/97 season, 63 percent of the tomatoes in Nogales were sold by these vertically integrated, Mexican-owned firms (Calvin and Barrios, 1998).

A grower organization, the Guatemalan Berry Commission (GBC), developed a system to characterize farms according to risk and allowed only certain farms to export. However, the plan had no enforcement mechanism for the 1997 spring season and another outbreak of foodborne illness (with no fatalities) in the United States and Canada was again traced to Guatemalan raspberries. Either the new practices were not completely implemented, were ineffective, or were not directed at the true source of contamination (Herwaldt et al., 1999). After consulting with FDA, the GBC voluntarily stopped raspberry exports to the United States on May 30, 1997. Guatemala estimated that stopping exports in the middle of the spring season resulted in a loss of $10 million in income (Powell, 1998).

After a second season with *Cyclospora* contamination problems, both the GBC and the government of Guatemala realized that more stringent controls and enforcement were required. In November 1997, the Guatemalan government created a commission to lead the effort to improve food safety. This gave the GBC's certification process enforcement power that was critical to making any export plan manageable.

In December 1997, FDA, not yet convinced that Guatemala had adequately addressed the *Cyclospora* contamination problem, issued an import alert for Guatemala for the following spring season, putting all shipments from the country under detention without physical examination (DWPE) and denying imports entry into the United States. Denying all imports of raspberries based on country of origin rather than rejecting products from a specific shipper with problems was an unusual response, and one used only after all other means of resolving the problem were exhausted. Generally, FDA collects random samples at the border, preventing entry of products that fail inspections. FDA can also detain a product without physical examination if the shipper has failed previous FDA port inspections or if FDA has other information indicating that the product might violate standards. The product may remain in DWPE status until the shipper proves that the product meets FDA's standards.

Denying imports without physical evidence was very rare in 1997, and in this case the import alert was based only on epidemiological evidence about past outbreaks and FDA observations on current production practices. Not until 2000 did FDA actually observe *Cyclospora* on a Guatemalan raspberry (Ho et al., 2002). Since 1997, FDA has become less reluctant to deny imports on epidemiological evidence alone.

FDA, Health Canada, the Canadian Food Inspection Agency, and Guatemalan officials consulted to consider improved intervention strategies for raspberry production. Beginning in the spring 1999 season, the United States allowed entry of raspberries produced under the Model Plan of Excellence (MPE), a joint program of the GBC and the government of Guatemala. Farmers are only allowed to join the MPE program and export by complying with a detailed program of food safety practices and successfully passing Guatemalan government inspections and FDA audits. Food safety practices include the use of filters for water and better worker hygiene facilities. The program also requires a code applied to each clamshell of raspberries, which allows traceback to an individual grower. Traceback and traceforward capability is critical in the event of a food safety problem. These tools can be used to revoke the export authority of any firms associated with a food safety problem in order to maintain the integrity of the MPE. In some cases, traceback can be used to eliminate Guatemalan raspberries as a potential source of contamination. In spring 1999, there were several outbreaks in the United States and Canada due to *Cyclospora* but the GBC could show, using its traceback and traceforward capabilities, that Guatemalan raspberries were not served at the events associated with the outbreaks. In 2000, there were two outbreaks associated with *Cyclospora* contamination of raspberries traced to one Guatemalan farm that was consequently removed from the MPE program. There have been no further outbreaks associated with Guatemalan raspberries since 2000. In 2002, only three raspberry growers remained in the MPE program. In 1996, before the contamination problem began, the number of growers was estimated to be 85.

The MPE program is a process standard. GAPs, for example, recommend that water quality be adequate for its intended use, but the MPE program requires farmers to use a nominal 1 micron filter as a prefilter to remove particulate matter and an absolute 0.45 micron filter for water used on plants and for employee hygiene. When a food safety problem becomes intractable, a process standard may be necessary rather than relying on the more flexible GAPs. Some firms might have been able to produce a safe product without the expensive filters, so a process standard may introduce inefficiency. However, the MPE process standard may have resolved the food safety problem faster, reducing economic losses, than if the industry had relied on voluntary GAPs.

The problem with raspberries affected other products. U.S. demand for Guatemalan blackberries also declined; blackberries were never cited as a definitive cause of any foodborne illnesses in the United States, although they were in Canada. In addition to possible food safety concerns, blackberries faced decreased demand because retailers prefer to buy a range of berry products all from one buyer if possible. When Guatemala could provide only blackberries, many buyers purchased berries from other regions that could provide the desired mix of berries. The blackberry industry has, however, fared much better than the raspberry industry; in 2001, U.S. imports of Guatemalan raspberries were 16 percent of 1996 levels and blackberries were 55 percent of their 1996 level. Guatemala has a voluntary food safety program for the much larger blackberry industry but it is much less rigorous than the MPE.

When confronted with the food safety problems in Guatemala, many berry shippers made alternative plans. One Guatemalan shipper closed all his domestic

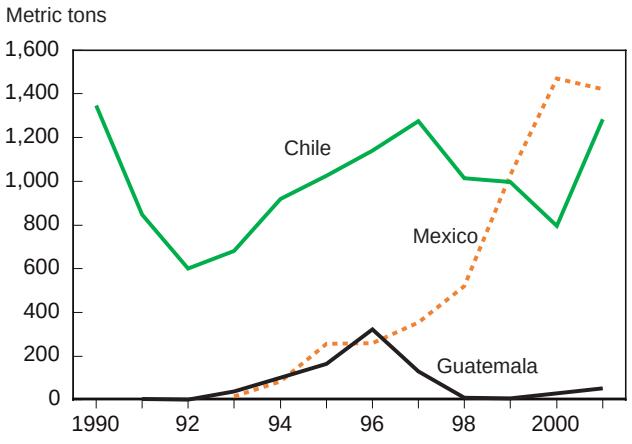
operations and began production in Mexico. A large Chilean firm that ships to the U.S. and Europe had raspberry operations in Guatemala but after the first outbreak this firm stopped shipping raspberries from Guatemala and began to develop production in Mexico. This change of strategy might have occurred even without the *Cyclospora* problems; it is cheaper to transport raspberries from Mexico by truck than from Guatemala by airfreight.

While Guatemala worked to increase food safety standards, other competitors, particularly Mexico, made inroads into its spring and fall market niches in the U.S. market (fig. 5.1). Prior to the 1996 outbreaks, the size and growth of Guatemalan and Mexican exports to the United States were very similar. With outbreaks in 1996 and 1997, many U.S. buyers decided to purchase raspberries elsewhere. Some buyers still feel that there is no reason to take a risk when there are alternate sources of raspberries. Others are reassured by the MPE, arguably the strictest industrywide program for raspberry production in the hemisphere.

In addition to the changes in Guatemala, the outbreaks led to improved private food safety programs for raspberry producers in Chile, Mexico, and the United States (although none of these countries were associated with *Cyclospora* contamination of raspberries). After the *Cyclospora* problem had such an adverse impact on the California strawberry industry, the California Strawberry Commission (CSC) developed a food safety program. California raspberry shippers (and their growers) also use this plan since all raspberry shippers also market strawberries.

Figure 5.1

**U.S. imports of raspberries, 1990-2001**




Source: U.S. Department of Commerce.

## Strawberries and Hepatitis A

In March 1997, more than 200 schoolchildren and teachers in Michigan contracted hepatitis A. Cases were reported in other States as well (Hutin et al., 1999). It was quickly determined that the source of the contamination was frozen strawberries processed by a firm in California. The processor had used fresh strawberries shipped to the United States in April 1996, a year earlier, from Baja California, Mexico. Most of the Mexican berries had been sold in the fresh market and some were sold to the processor (FAS, 1997). FDA was able to determine that California-grown strawberries were not the source of contamination. However, FDA could not determine whether the Mexican-growers fruit was contaminated in Mexico at the farm level or at the California processor. The product was not contaminated in Michigan.

General concerns about the safety of fresh strawberries affected demand for berries from all sources. The monthly price received by growers fell 40 percent from March to April in 1997, compared with an average decline of 16 percent for the years 1990-1996 and 1998-2000. Initial estimates from the CSC put losses at $15 million with later estimates at $40 million, but both estimates are subject to debate (Richards and Patterson, 1999). As some of the California growers had joint ventures in Mexico, they shared in the financial losses there too.

The 1996 outbreak associated with *Cyclospora*-contaminated raspberries, when California strawberries were initially and incorrectly implicated, increased the strawberry industry's awareness of their vulnerability to food safety problems. Following that outbreak, the CSC began developing the voluntary Quality Assurance Food Safety Program to help producers improve their food safety standards and mitigate microbial contamination. The CSC worked with FDA and the California Department of Health Services to develop the program. This was one of the earliest good agricultural practices programs for the produce industry that focused on mitigating microbial contamination. An industrywide food safety program is expensive and the CSC has spent about $250,000 to date.

California standards for production practices and documentation were already fairly rigorous, but the CSC's Quality Assurance Food Safety Program strengthened both. Traceback is a critical part of the voluntary program. If there is a problem, the industry wants to be

able to say the product is not from California or trace the product back to the field and isolate the problem farm from the rest of the industry. Growers use a variety of traceback systems. The best systems include information on shipper, date, field, and picker on each box.[10] It is not enough to just have safe products; growers must be prepared to quickly demonstrate their food safety program in the case of an outbreak. The Quality Assurance Food Safety Program encourages farmers to always have all their documents regarding food safety ready in the case of emergency. This includes documents regarding water, soil, and any fruit testing; pesticide and fertilizer use; and records of hygiene practices.

This program was introduced in November 1996 and was in effect, although still in its infancy, when the strawberry problem occurred in 1997. Although the contaminated product was frozen strawberries, consumer confidence in fresh strawberries was also shaken. In response to a second year of media scrutiny, the CSC was prepared to deflect unwanted attention from their industry. The CSC announced that fresh California strawberries were not responsible for the outbreak and that because growers were using a sophisticated food safety program they were unlikely to ever be responsible for such an outbreak. Researchers estimated the impact of positive and negative publicity in this case. Prices responded more strongly to bad news than good news, so it is very important to prevent or stop negative publicity as soon as possible (Richards and Patterson, 1999).[11] Before the outbreak of hepatitis A associated with strawberries, the growers in Mexico were members of the California Strawberry Commission. After the outbreak, the Commission decided to limit membership to California producers to maintain the California focus and a consistent message in its marketing program. However, because the Baja California and California strawberry industries are so integrated, with growers in Mexico marketing through California shippers, the Mexican producers still benefited from the CSC's food safety research.

[10] In the case of strawberries, information on the picker was fairly easy for many shippers to incorporate into their traceback programs. Because the strawberry industry uses an hourly wage as well as a piece-rate payment, the industry already had to be able to tie product to individual pickers.

[11] Two other aspects of the outbreak kept the news in the public eye. The processor illegally sold the frozen berries as U.S.-grown berries to the National School Lunch Program, which requires domestic product (Richards and Patterson, 1999). Also, many schoolchildren were immunized against hepatitis A as a precautionary measure when there was concern that some of the contaminated product might have been served in Los Angeles area schools.

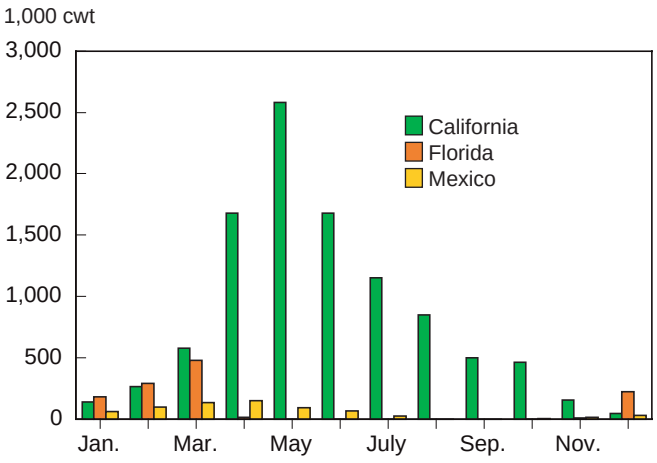
Although it was never proven that the contamination occurred in Mexico, the outbreak had a serious impact on the Baja California, Mexico industry. The United States imports very small amounts of fresh strawberries—just 6 percent of total U.S. consumption in 2001—and almost all of that is from Baja California, Mexico. The Baja California season runs from January to July, with the highest production typically in April. Baja California production augments the low winter supply in the United States. Figure 5.2 shows the importance of Mexican strawberries during the winter for firms offering a year-round supply.

The publicity surrounding the hepatitis A outbreak had an immediate effect on fresh strawberry shippers from Baja California. Figure 5.3 shows the precipitous decline in fresh strawberry shipments from Mexico in April 1997, compared with 1996. Due to the collapse of market demand in the United States, the primary market for Baja California producers, U.S. shippers told their Mexican growers to stop harvesting, and about 200 hectares of strawberries in Baja California were left unharvested (out of 563 planted hectares).

In response to the outbreak, the Baja California strawberry growers and their local grower organization established more stringent food safety standards (FAS, 1998). Since most of their production is exported, the growers needed to ensure their product would be accepted in the United States. Growers started using third-party audits immediately for strawberries as well as other produce items. Many of the large U.S. third-party audit firms have operations abroad in important growing areas. Some growers

Figure 5.2

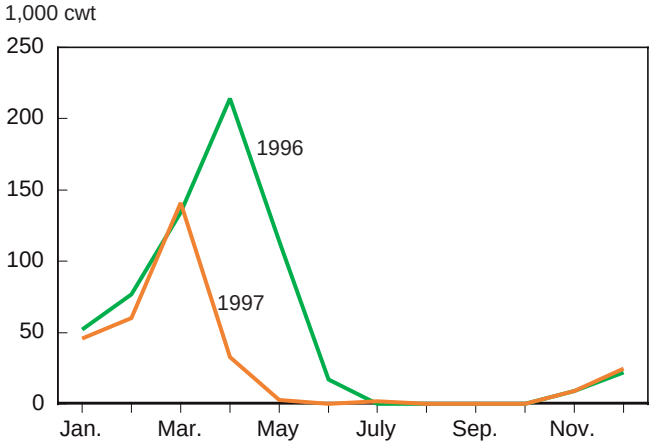
**U.S. monthly strawberry shipments, 2001**




Source: Agricultural Marketing Service, USDA.

Figure 5.3

**Strawberry shipments from Mexico, 1996-1997**




Source: Agricultural Marketing Service, USDA.

adopted the CSC's food safety program. In an integrated industry, new practices in the United States are quickly adopted in Baja California.

FDA officials went to the California processor and the Mexican strawberry fields to inspect operations but results regarding the origin of the contamination were inconclusive. FDA provided training on GAP recommendations that were just being developed. These recommendations provided guidelines similar to those of the CSC program. The Mexican state-level department of agriculture was instrumental in disseminating information on FDA's GAP recommendations to growers. Since that time, they have also hosted FDA and the California Department of Food and Agriculture, among others, for classes on food safety (Avendaño, 2002). At the time of the outbreak, there was no effective way to test for the presence of hepatitis A on strawberries so there was no increased microbial surveillance specifically targeted at this pathogen. FDA was also involved with the recall of frozen strawberries and processed products made with the berries. In the case of produce consumed in fresh form, there is rarely any product to recall by the time an outbreak is detected and the source is identified.

Although fresh strawberry imports from Mexico in 1997 were only 47 percent of 1996 levels, imports in 1998 increased to 86 percent of the earlier level. In 1999, U.S. imports of fresh strawberries from Mexico were at record levels. This outbreak had only a short-run impact on fresh trade.[12] Apparently U.S. shippers were confident that their Mexican strawberry growers had taken adequate precautions.

## Cantaloupe and *Salmonella*

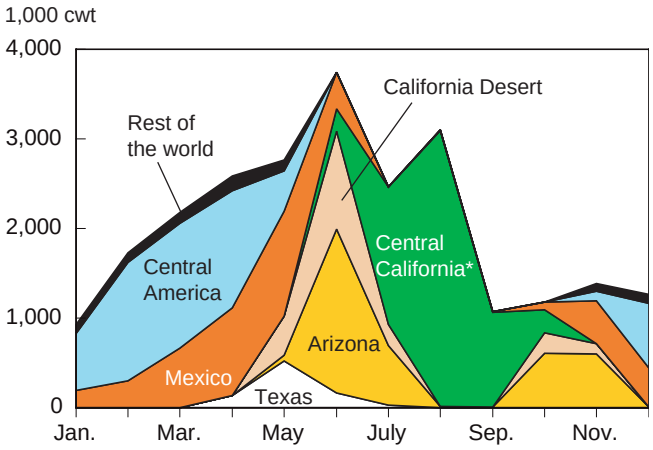
In 2000, 2001, and 2002 there were outbreaks of *Salmonella* associated with Mexican cantaloupe. Mexico exports cantaloupe from various regions during its long export season; in each case, contaminated cantaloupe came only from one region in the south. While Mexico only supplied 7.2 percent of total U.S. consumption in 2001, Mexico and Central America are the major suppliers during the winter season (fig. 5.4 shows suppliers in 1999, the last year of trade without *Salmonella* contamination problems).

In 2000, cantaloupe from southern Mexico were implicated in a *Salmonella poona* outbreak. Forty-seven people became sick in March and April and by late May cantaloupe was implicated (Anderson et al., 2002). The outbreak occurred during the spring when Mexico ships a large volume of cantaloupe to the U.S. market. By the time the outbreak was traced to cantaloupe, the Mexican season was coming to a close. U.S. producers then bore the brunt of consumer backlash against cantaloupe. The outbreak was traced to a particular shipper in Arizona selling cantaloupe from southern Mexico. FDA issued an import alert for this shipper and one farm. In the fall, FDA visited the farm in southern Mexico. Although scientists are more familiar with *Salmonella* than emerging pathogens like *Cyclospora*, they cannot always determine exactly how

[12] U.S. imports of frozen strawberries from Mexico were higher in 1997 than in the previous year. Frozen strawberries come from central Mexico and were apparently not affected by concerns about food safety problems in Baja California.

Figure 5.4

**U.S. cantaloupe supply, 1999**




*Central California shipments are estimated.
Source: Agricultural Marketing Service, USDA.

the contamination occurred and how to definitively resolve the problem. The primary host for *Salmonella* is animals, followed by humans. A firm shipping product contaminated with *Salmonella* is most likely failing to follow GAPs and GMPs. FDA prepared an adverse findings report, which identified farm activities that were inconsistent with GAPs and GMPs; FDA does not tell a farmer how to fix the problem. When the distributor provided documentation demonstrating corrective actions taken to respond to FDA's adverse findings, the import alert was lifted and the firm and farm resumed exporting to the U.S. market.

In late spring 2001, two additional outbreaks of *Salmonella* attributed to cantaloupe occurred (first *Salmonella poona* and then *Salmonella anatum*). Fifty people were sickened and two died from *Salmonella poona* (Anderson et al., 2002; FDA, 2001c). Fewer people were sickened in the *Salmonella anatum* outbreak. Although *Salmonella* can cause serious and sometimes fatal infections in young children, frail or elderly people, and others with weakened immune systems, healthy people who become infected generally experience less severe medical problems. Based on the traceback investigation, FDA determined that the contaminated cantaloupe in 2001 came from the same farm in Mexico and shipper in Arizona that were implicated in the 2000 outbreak. The firm is a large shipper of winter melons from Mexico and has been in the business for 30-40 years (*The Packer*, 2001). Either implementation of the new practices was inadequate or the changes failed to address the problem. Again, by the time cantaloupe from Mexico were determined to be the culprit, most of the Mexican shipping season was over. FDA announced that anyone who had any cantaloupe from this company should remove it from sale, and the company issued a recall of its cantaloupe. Growers from northern Mexico were still selling small volumes to the United States. Some shippers in Arizona told their Mexican growers to sell to the Mexican market. On May 25, 2001, FDA issued an import alert for the distributor and grower that is still in effect in early 2003. The firm cannot ship cantaloupe to the United States but it can still ship honeydew melons.

In May 2002, an outbreak of *Salmonella poona* in the United States and Canada was associated with Mexican cantaloupe shipped through McAllen, Texas. Fifty-eight cases were identified (Anderson et al., 2002). The importing firm issued a voluntary recall and FDA issued an import alert (FDA, 2002a). This was the third season of outbreaks traced to southern Mexico. The Mexican government is investigating the source of contamination.

U.S. cantaloupe imports from Mexico in the 2001-2002 season were 64 percent of the previous season's volume (fig. 5.5). However, one large multinational firm's decision to move operations to Central America accounts for at least some of the decline. Other factors behind declining imports from Mexico include production problems and increasing input costs. Honeydew imports in 2001-2002 were 97 percent of the previous season's volume. Unlike the case in Guatemala where problems with raspberries affected demand for blackberries, commercial buyers do not seem to be particularly worried about honeydew melons from Mexico.[13]

Repeated outbreaks within an industry prompt several concerns. First, the industry fears that when people get sick, investigators may immediately, and incorrectly, focus on the product with a history of trouble. Second, the produce industry is concerned that FDA might issue a consumer warning about eating the contaminated produce.[14] Third, growers are concerned that if a problem looks like it affects more than a few growers, the FDA might decide to initiate an import alert against all producers from a particularly country, as in the case of Guatemalan raspberries. Fourth, there is concern that an ongoing problem could hurt the reputation of other products from the same region. Fifth, FDA introduced a mandatory food safety program for fruit and vegetable juices after three outbreaks. FDA always has the option of making food safety programs mandatory—something most growers would like to avoid.

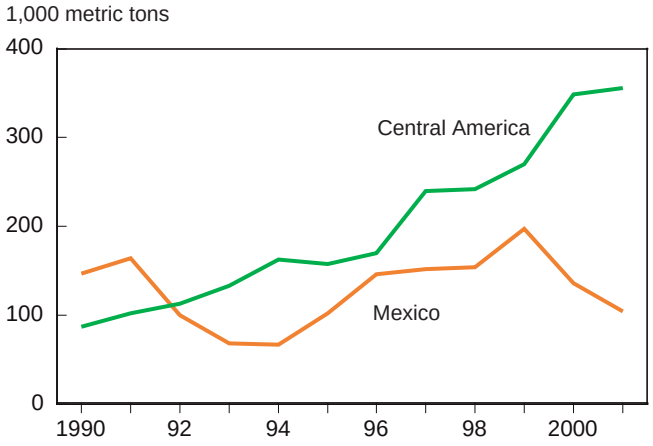
The California cantaloupe industry's efforts to promote food safety predate the 2000-2002 *Salmonella* outbreaks associated with Mexican cantaloupe. Over the years, cantaloupe has been associated with several other foodborne disease outbreaks. Outbreaks of *Salmonella* in the

[13] Although all field-grown melons mature on the ground and are therefore exposed to potentially contaminated soil and irrigation water, cantaloupe appear to be particularly susceptible to microbial contamination, perhaps because of the rough webbing on the rind, which may harbor pathogens (FDA, 2001a). Smooth-skinned honeydew melons, which are often grown in similar areas, appear to be less prone to contamination problems.

[14] Beginning in 1995, there were numerous outbreaks traced to sprouts that the industry could not seem to resolve. In 1998, FDA warned high-risk groups to avoid eating raw alfalfa sprouts. Then in 1999, FDA broadened the warning to include all consumers, not just those at high risk, and all types of raw sprouts (FDA, 1999). This warning was repeated in 2002 and expanded to include lightly cooked mung bean sprouts (FDA, 2002c).

Figure 5.5

**U.S. imports of cantaloupe from Mexico and Central America**




Source: U.S. Department of Commerce.

United States in 1990, 1991, and 1997, and in Canada in 1991 and 1998 were traced to cantaloupe (FDA, 2001d). In 1991, the news about contaminated cantaloupe emerged in August, when half of the large Central Valley crop in California is shipped (fig. 5.4). The U.S. cantaloupe industry initiated a food safety program called the "Melon Safety Plan" (Tauxe, 1997). Once the crisis was over, however, the program ran out of money and sputtered to a stop.

Since 1998, the California Melon Research Board, which represents all California melon producers, except watermelon growers, has spent more than $300,000 on funding melon food safety research at the University of California at Davis. Growers who remember the economic chaos of the 1991 outbreak and are concerned about the potential impact of any new food safety problems fund the research. This group of California growers, with the largest cantaloupe production in the United States, views this investment in food safety as critical for the reputation of their industry. This research focuses on California cantaloupe and while the general principles of this research will be widely applicable, the specifics will not. California melons are mostly field packed and forced-air cooled. In other parts of the United States, Mexico, and Central America, shed packing and cooling with cold water or ice are more common and these practices pose different food safety challenges.

Beginning in 2000, the California Cantaloupe Advisory Board (a marketing order for California cantaloupe grown north of Bakersfield) began requiring additional traceback information on cantaloupe boxes as part of their State marketing order (this program was voluntary in 1999). This was not a very difficult process. California cantaloupe is packed in the field and the Board had already contracted with the California Department of Food and Agriculture to inspect cantaloupe during harvest for quality control and apply an inspection sticker to every box (growers pay the Board a per-box fee for this service). Cantaloupe from this area cannot be sold without the sticker identifying the county and shipper. The new program requires information on the packing date, field, and packing crew, which allows a grower to trace the problem right back to a particular part of a field. Some growers had already been providing this additional information. Adding this additional traceback information to the box was neither particularly costly nor complicated. It did take some administrative changes, however.

To be able to require traceback, the members of the Board had to propose a change to their marketing order and vote on it. Their original marketing order covered grades and quality standards. The new marketing order specifically approves "such grade and quality standards of cantaloupes as necessary, including the marking or certification of cantaloupes or their shipping containers to expedite and implement industry practices related to food safety" (California Department of Food and Agriculture, 2000). If another outbreak were to occur, this program would allow the industry to immediately pinpoint the source of the problem or deny that the problem is due to California cantaloupe, depending on the situation. This may be the only mandatory program for produce in the United States that requires such detailed traceback information on each box.

The Mexican cantaloupe industry is also concerned. In FDA's first round of microbial testing of produce, both imported (1999-2000) and domestic (2001-2002) shipments of cantaloupe tested positive for *Salmonella*. The FDA followup survey (beginning in January 2001) on imported cantaloupe showed no contaminated samples from Mexico. CDC contends that the interpretation of the 2001 results are limited by the small size—only 29 samples (Anderson et al., 2002). Mexican industry insiders feel that the initial results from the FDA served as a wake-up call to growers; an indication that normal operations would not be sufficient and that the cantaloupe industry would have to be seen as proactive on the food safety issue to maintain its reputation. This may be particu-

larly important when cantaloupe from Central America are also available during much of the Mexican season. Results from the 2002 sampling program are not yet publicly available.

In 2001, the Mexican government agency in charge of food safety, Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (SENASICA), began developing a food safety program for cantaloupe. The program is based on planting permits, production programs requiring GAPs and GMPs for growers and packinghouses, and monthly melon testing. The program also includes more sophisticated traceback capability. As in other cases, it is imperative to identify any grower or packer that harms the integrity of a food safety program. All exports must have an international phytosanitary permit, which will only be issued if compliance with GAPs and GMPs is certified (*The Packer*, 2002c). FDA and SENASICA were discussing this program in early summer of 2002. Parts of this system were in place on a voluntary basis in some states in fall 2002. Also in 2002, FDA and SENASICA began preparing to conduct joint training for government inspectors and farmers.

U.S. cantaloupe growers lobbied FDA to take a more aggressive role in this evolving case (this was apparently not the case in the raspberry outbreaks). On October 28, 2002, FDA issued an import alert against all cantaloupe imports from Mexico (FDA, 2002d). Although the outbreaks had been traced just to two States in southern Mexico (Michoacan and Guerrero), FDA justified the countrywide import alert because of FDA samples showing *Salmonella* contamination in cantaloupe from other States (Sonora, Jalisco, Colima, Coahuila, Mexico, and Tamaulipas). Also, FDA was concerned that with a regional approach, melons from restricted regions could be commingled with melons from a nonrestricted area. On November 4, 2002, Canada issued a similar import alert for all Mexican cantaloupe (CFIA, 2002).[15]

Mexican growers have complained about the timing of the decision—just as growers in Sonora were ready to begin harvesting cantaloupe for the U.S. market. They also complained that the penalties FDA is imposing are higher than those for U.S. cantaloupe producers with similar food safety problems. While FDA samples showed *Salmonella* contamination in shipments from several regions of Mexico, samples from the U.S. in 2001 also showed contamination, but the U.S. growers are not faced with similar restrictions (FPAA, 2002). Also, for Mexican growers to be removed from the countrywide import alert, they will have to demonstrate higher food safety standards than U.S. growers. An individual Mexican firm can petition FDA to remove their firm from the import alert by providing documentation of their food safety program. According to the import alert announcement "after reviewing these submissions, FDA, either solely or in conjunction with the relevant Mexican regulatory authority may conduct a limited number of onsite inspections of the growing/processing areas to audit the validity of the information submitted to FDA. FDA intends to give first priority to firms or growers who have their operations inspected by a third-party audit firm that has expertise in agricultural and transportation processes." A third-party audit showing compliance with GAPs will not necessarily be enough to be removed from the import alert list. In contrast, U.S. cantaloupe growers are not required to use GAPs, although many comply voluntarily.

November 2002 saw developments on both sides of the border. On November 8, Mexico presented a formal complaint to the World Trade Organization's Sanitary and Phytosanitary Committee claiming that the U.S. import alert against all Mexican cantaloupe was not consistent with U.S. trade commitments with respect to discrimination, protectionism, and unnecessarily trade restricting actions (SAGARPA, 2002). On November 13, the Mexican government published legislation that gave the government legal authority to require all cantaloupe growers to comply with the new food safety program. On November 20, importers associated with the 2000 and 2001 outbreaks were indicted in the United States on Federal charges of "trying to impede and defeat lawful government functions of the U.S. Customs Service and the U.S. Food and Drug Administration" in their traceback efforts (*The Packer*, 2002d). The importers entered a plea of not guilty and the trial, initially scheduled for January 2003, has been delayed. On November 27, 2002, FDA authorized imports from two farms from the northern Mexican state of Sonora (*The Packer*, 2002e). This paper only covers events through November 2002 in a case that will continue to evolve.

[15] In the raspberry case, between 1998 and 2000, either the United States or Canada had an import alert but never in the same year. Since *Cyclospora* was an emerging pathogen, it was not clear what actions were adequate to resolve the problem. This inconsistency in policy raised concerns in Guatemala about the scientific basis of trade policy.

# Summary of Responses to Food Safety Problems

## Private Response

In a food safety outbreak, the grower's first line of defense is to adopt GAPs if they are not already in place.[16] Some growers develop their own food safety programs that are even more stringent than FDA's GAP guidelines. However, it is often difficult to determine how contamination occurred and what practices are adequate to resolve the problem. In Guatemala the problems took several seasons to resolve and the exact means of contamination was never determined. It is not clear how long it will take to solve the problem in Mexico since neither the extent of the problem nor the source of contamination have yet been identified.

In the past, an individual grower could adopt a better food safety program when faced with a food safety problem, but it was difficult to signal to buyers that the firm's product was safer than that of others in the industry. In the raspberry case, the two market leaders—large U.S. and Chilean firms—adopted new food safety programs for all their growers in different countries. These firms are so large that the cost of improved practices and additional testing was likely small compared with the losses associated with a potential food safety problem and damage to their reputation. If consumers and large-scale buyers recognize the brand name, then these firms may be able to maintain consumer confidence even if other firms' reputations suffer from a food safety problem.

The growth in the use of third-party audits for GAPs has provided growers with a new tool to indicate that appropriate practices are in place. An audit can reduce asymmetric information between the grower and shipper and between the shipper and commercial buyers. In the late 1990s, with GAPs in place, third-party auditors began to verify food safety programs for field operations as being in compliance with these guidelines. While FDA developed GAPs, the private sector has developed the third-party auditing industry for microbial contamination.[17] There is no government oversight of third-party audit firms—an issue that concerns many in the produce industry (*The Packer*, 2002a). Standards may vary between auditing firms and between retailers requiring use of audits. Growers and shippers are concerned that this raises their costs if they need to have different audits for different buyers.

Another concern regarding third-party audits for microbial food safety is that this focus is relatively new for produce. The third-party audit industry has its roots in pesticide residue testing and auditing of indoor HACCP programs. Examining produce for pesticide residues is much easier than looking for microbial contamination. Although adherence to GAP guidelines and successful third-party audits of food safety programs do not guarantee food safety, FDA is concerned that some outbreaks have been traced back to firms that have successfully completed third-party audits.[18] An audit can verify that growers are using certain food safety practices that should help reduce microbial contamination but it is much harder to observe the potential for contamination. For example, GAP guidelines say that water must be adequate for its intended use. An auditor may take water samples in an attempt to provide a more comprehensive assessment of risk. However, water samples can be problematic since water contamination is not necessarily a constant presence. A sample of surface water that tests negative for microbial organisms on one day indicates nothing

[16] Of course, some firms already had sophisticated food safety practices in place, even before the more recent concern with food safety. Many of the largest firms have their own food safety programs with trained scientists overseeing production and packing operations. This is particularly important for the new fresh-cut products like bagged salads which often have consumer-recognized brands. Investment in food safety protects the brand name. Branding is becoming more common in produce; in 1997, 19 percent of retail produce sales were branded products, compared with only 7 percent in 1987 (Kaufman et al., 2000).

[17] In 2001, USDA's AMS began a pilot program offering third-party audits for produce in several States, the Fresh Produce Audit Verification Program (AMS, 2002). The AMS audits are similar to private audits. The AMS program does not seek to influence the third-party audit industry, just to provide another source of the same service. The program is run through the State departments of agriculture. AMS has inspectors at shipping-point locations and has experience working with growers. This program grew out of a request from New Jersey growers. Currently, the program is offered in New Jersey, California, and Oregon. It is just starting in Washington and Florida. The cost of an AMS audit is similar to those offered by the private sector. The typical audit takes 5-6 hours. In California, an audit costs $65 per hour plus $31 per hour in travel costs (*The Packer*, 2002b).

[18] This concern has become more obvious in the import alert for Mexican cantaloupe, which states that FDA will conduct their own investigations and not rely solely on third-party audits. This is similar to FDA conducting audits of Guatemalan raspberry farms in the early stages of the MPE program.

about the chances of contamination on another day. Tests of water from wells that are protected from surface contamination are more helpful; for example, a yearly sample from such a well might be sufficient to determine the overall water quality.

Growers have another reason to adopt GAPs and use third-party audits. In 1999, Safeway, the third largest U.S. food retailer, expanded their food safety program to require all their suppliers of certain commodities to verify that they follow government food safety standards and specifications in production and packing. Some other retailers have followed suit. To qualify as a Safeway supplier, a grower must have an independent third-party auditor verify that they are using GAPs for production and GMPs for packinghouses. Requiring verification of use of GAPs and GMPs was a new idea and met with initial opposition. Domestic and imported produce sold by Safeway must meet the same standards. Research covering a select group of U.S. fruit and vegetable shippers indicates that in 1999, almost half of those studied provided third-party audits for GAPs or GMPs for at least one of their buyers. While shippers were not always happy about complying with this request, most indicated that they would implement verification programs in response to changing buyer preferences (Calvin et al., 2001).

In each of the case studies, shippers tried to distance themselves from those associated with a food safety problem. Shippers can reduce their risk by requiring growers to provide third-party audits or by dropping growers with less sophisticated food safety programs or more challenging environments. The problems in Guatemala may have helped the small but growing industry in Mexico since shippers could satisfy most of their needs with Mexican raspberries. Mexico cantaloupe growers may face a similar situation in the future if U.S. buyers decide to reduce their risks by switching to Central American cantaloupe.

## Grower Organization Response

Grower organizations have also been important forces for resolving food safety problems. Beginning in the mid-1990s, the fresh produce industry became aware of the potential cost of food safety problems related to contamination at the farm level. Many trace this heightened awareness to the well-publicized 1996 outbreak of *E. coli* O157:H7 that was traced to mesclun (lettuce mix) grown and packed on one small farm in California. This was the first reported multistate outbreak of *E. coli* O157:H7 associated with lettuce (Hilborn et al., 1999). It was also one of the earliest cases clearly identifying microbial contamination at the farm level.

Concerned about potential government regulation, the Western Grower's Association, which represents the California and Arizona produce industry (including almost all U.S. lettuce production), and the International Fresh-cut Produce Association, took the initiative and developed their own set of guidelines for fresh produce food safety. Similarly the CSC developed its own set of guidelines following the raspberry contamination problem in 1996. FDA's GAP guidelines published in late 1998 built, in part, on these earlier industry efforts.

One grower organization has been active in providing guidance to the third-party audit industry. The United Fresh Fruit and Vegetable Association has developed a training program on food safety auditing. Growers were concerned that some auditors experienced only in indoor audits were unfamiliar with the produce industry and outdoor settings where some factors cannot be controlled. This program also serves a need for continuing education for growers interested in evaluating their own food safety programs.

Grower organizations have become more concerned about the reputation of their crops for food safety. A very large and important firm may be able to maintain its reputation despite the actions of others in the industry, but most firms must rely on the overall reputation of the industry. Retail buyers may know that a particular firm has never been associated with an outbreak, has a strong food safety program, and has successful third-party audits for adherence to GAP principles, but consumers generally do not have that great a knowledge of the industry. News reports of an outbreak associated with a particular grower may affect consumer perceptions about all growers of that product in that same area or anywhere else.

A grower organization's effort to build a reputation for food safety is a public good. At least in the short run, everyone benefits from the reputation for safety even if they are not investing in improved food safety. In each of the three cases studied, grower organizations have focused on developing systems to trace products from final selling point back to the grower, which encourages grower responsibility and reduces the free-rider

problem.[19,20] In the case of an outbreak, a grower organization that encourages traceback can prove to the public that their product is not responsible for the problem. Or, where the industry is responsible for the outbreak, the responsible grower or growers can be identified and damage can be limited.

In the raspberry case, the Guatemalan food safety program with its traceback and traceforward capabilities is mandatory. With the California Strawberry Commission, the Quality Assurance Food Safety Program is voluntary but the Commission is confident that all shippers use some sort of traceback, although the degree of sophistication varies. The Baja California strawberry growers appear to follow the California Strawberry Commission's program closely. In the case of cantaloupe, the California Cantaloupe Advisory Board's traceback program is mandatory. Mexico's new cantaloupe food safety program with enhanced traceback is also mandatory.

This level of traceback capability may not be representative of other industries who have not yet faced food safety problems, even though traceback capability is an integral part of GAPs. The difficulty of implementing a traceback program may vary by crop because of particular harvesting or marketing practices. For example, products that are packed in the field can easily be labeled with the origin of the product. If products are harvested and then packed in a central facility, a little more care is required to maintain traceability. Crops like tomatoes present a particular traceability challenge. They are often harvested, packed, and then sent to repackers where tomatoes from several producers may be commingled before being resorted by maturity.

## Government Response

FDA's most important contributions to improving food safety for produce is the development of guidelines for food safety practices. The value of GAPs will increase as science provides more answers regarding how to reduce risk of microbial contamination.

Because it is so difficult to identify microbial contamination on produce, FDA cannot rely on random testing at the border to detect contaminated produce. FDA will do inspections when there is reason to think there might be a problem. Because of the problems with cantaloupe in recent years, FDA conducts microbial testing on imported and domestic cantaloupe. Instead of focusing on testing, FDA has concentrated much of its efforts on education in foreign countries. All efforts to solve food safety problems abroad reduce the burden on the consuming public and on the FDA and CDC, which investigate outbreaks. In 1997, FDA spent 6,274 hours investigating the *Cyclospora*-contaminated raspberries (U.S. GAO, 1999).

When invited by a foreign government, FDA will visit individual farms associated with contamination problems and identify practices that are not consistent with GAPs. Findings compiled from these visits are used to identify trends for future training and guidance development. FDA, in association with the University of Maryland, teaches food safety practices in the United States and abroad through the Joint Institute of Food Safety and Applied Nutrition. This program has provided classes on GAPs. In addition, FDA provides training for conducting farm investigations. In 2002, FDA conducted several training courses in Mexico on how to do farm investigations for produce.

When an outbreak is associated with imported produce, FDA must determine whether the problem can be easily solved or whether the individual firm or country should not be allowed to ship to the United States until the problem is fixed. Traditionally, FDA relies on laboratory identification of pathogens on a product before making decisions on withdrawing a product from the market or banning its import. This is a problem for fresh produce, which is rarely available for analysis when an outbreak develops. Over time, FDA has become more comfortable with making decisions based on epidemiological evidence alone. The *Cyclospora* case in Guatemala was the first big produce case that relied solely on epidemiology. The Mexican *Salmonella* case demonstrates again the reliance on epidemiology.

The role of FDA varies depending on the case. For Guatemalan raspberries, FDA eventually banned all imports because an individual farm could not be iden-

[19] Even before recent food safety problems and emphasis on using GAPs, some firms voluntarily adopted traceback programs as a good business practice.

[20] The Federal Government does not currently require traceback nor monitor voluntary activities (Golan et al., 2002). However, the newly enacted Public Health Security and Bioterrorism Preparedness and Response Act of 2002 will eventually require some traceability capability (FDA, 2002). Although farmers are exempt, shippers and most other firms in the distribution channel will be required to be able to identify where any product came from and where it went to ("one up, one down"). FDA must publish their regulations for establishing this system by December 12, 2003.

tified and the problem seemed pervasive. FDA and CDC sent researchers to Guatemala to investigate the industry and provide assistance in developing a production system to minimize the potential of microbial contamination. FDA's role in the Mexican strawberry case appears to have been limited at the farm level, particularly since no one could determine where the contamination occurred. In this case, however, the strawberries were processed so FDA was involved in the recall of the processed product. With a fresh product, there is often no product to recall. In the Mexican cantaloupe case, FDA first issued import alerts for three firms selling cantaloupe associated with *Salmonella* outbreaks. In late 2002, FDA banned all cantaloupe imports from Mexico. FDA is evaluating petitions from individual Mexico growers for exemption from the ban.

State organizations, such as the California Department of Food and Agriculture, are also involved in food safety outreach programs to producers in other countries. Again, the motivation is self-interest since contamination problems traced to imports can have such negative impacts on U.S. producers.

As the case studies demonstrate, in most cases foreign governments have tried to resolve food safety problems, although perhaps not as aggressively as desired by the United States in the early stages. In Guatemala, the government became involved in the GBC's efforts to develop a workable and enforceable food safety plan. In the strawberry case, the industry in Baja California acted almost as a part of the U.S. industry and benefited in an indirect way from food safety initiatives of the CSC. Mexican government activities appear to have been limited to the state level in that case. In November 2002, the Mexican government put into place a food safety program to try to resolve the cantaloupe problem.

## Conclusions

Food safety and produce trade are clearly compatible; the vast majority of imports are never associated with food safety outbreaks. Producers in the United States and foreign countries, grower organizations, governments, and commercial buyers are actively involved in improving food safety.

Producers are self-motivated to provide safe produce because of the financial consequences of an outbreak traced back to their operation. Of course, there are always some cases where people will not invest sufficiently in food safety practices because they think their product is safe or they deliberately cut corners. As traceability improves, however, the probability that responsibility for contaminated food will fall on those farmers with inadequate food safety programs will increase.

Grower organizations are motivated because of the public good nature of a product reputation. Since an outbreak anywhere can have a negative impact on consumers' perceptions of the product, grower organizations must do something to try to reassure the public that their product is safe and distinguish themselves from other groups of growers associated with a problem.

Fears of economic and reputation losses if a contaminated produce item is traced to their firm motivate retailers and other commercial buyers to demand high food safety standards. Buyers want to know about a grower's food safety plan. Some demand third-party verification of compliance with GAPs and GMPs.

In the United States, FDA encourages farmers to follow guidelines to reduce microbial contamination in produce. It does have the power to impose mandatory food safety programs if necessary. With respect to trade, FDA restricts imports from individual firms or all producers in a region or country when food safety problems cannot be resolved. FDA has been active in promoting improved food safety abroad. In both Mexico and Guatemala, microbial food safety programs have traditionally been voluntary. Government programs became mandatory for the particular products after food safety problems resulted in U.S. import alerts.

There is no reason to think that this trend toward more sophisticated food safety programs is any more difficult for foreign growers to cope with than for domestic growers. However, increased concerns about microbial food safety programs pose particular challenges for smaller farmers in both the United States and foreign countries. When there are food safety problems, the costs of production increase for everyone producing for the U.S. market. New fixed costs, such as purchasing a water filtration system, would be particularly problematic for small producers spreading the cost of the new investment over smaller volume of output. Also, smaller farmers (or geographically dispersed farmers) might not be able to support the grower organizations that have been so important in resolving food safety problems.

The case studies show that failure to resolve food safety problems quickly can have serious impacts on an indus-

try and trade. A major policy challenge is to determine when government intervention may be required to resolve a problem. Science is not as definitive as desired when trying to make decisions about trade and food safety. While some practices clearly increase the probability of microbial contamination, it is often difficult for FDA and others to identify the source of contamination and the new practices that would yield safer food. There is a chance that too aggressive a stance would unnecessarily restrict international trade when using GAPs might resolve the problem in the next season. In the hepatitis A outbreak linked to strawberries, if the contamination occurred in Mexico, use of GAPs alone may have been sufficient to solve the problem (or it may be a sporadic problem that might pop up again in the future). Restricting trade can be economically devastating for an industry, as in the Guatemalan raspberry case. However, the raspberry and cantaloupe cases show that it can take several years to resolve a problem and in both cases the foreign governments intervened. In these cases a more moderate response may be inadequate, leading to more outbreaks and economic losses in affected industries.

In each case, damage was not limited to the producers of the contaminated product. Anyone producing a product for the U.S. market, including U.S. growers, may be caught in the consumer backlash against a product and will probably have to adopt more stringent food safety programs. Given the widespread impacts of food safety outbreaks, there may be opportunities for grower organizations in different countries to organize joint efforts to resolve problems. Organizations would have to weigh the negative fallout of a food safety problem originating with their competitors against the potential gain if their competitors' sales were restricted. The costs and benefits would vary by industry.

The case studies show the actions of growers, grower groups, and governments caught up in foodborne illness outbreaks. Future research should investigate what other sectors of the produce industry, which have not yet faced the economic disruption of a foodborne illness outbreak, are doing to prepare for the possibility.

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*Chapter 6*

# Mycotoxin Hazards and Regulations

## Impacts on Food and Animal Feed Crop Trade

Erik Dohlman[1]


## Summary

The risk of contamination by mycotoxins is an important food safety concern for grains and other field crops. Mycotoxins are toxic byproducts of mold infestations affecting as much as one-quarter of global food and feed crop output. Food contaminated with mycotoxins, particularly with aflatoxins, a subcategory, can cause sometimes-fatal acute illness, and are associated with increased cancer risk.

To protect consumers from these health risks, many countries have adopted regulations to limit exposure to mycotoxins. As with many food safety regulations, domestic and trade regimes governing mycotoxins often take the form of product, rather than process, standards. The World Trade Organization's Sanitary and Phytosanitary Agreement states that these standards must be based on sound risk assessments. However, diverging perceptions of tolerable health risks—associated largely with the level of economic development and the susceptibility of a nation's crops to contamination—have led to widely varying standards among different national or multilateral agencies. For example, of the 48 countries with established limits for total aflatoxins in food, standards ranged from 0 to 50 parts per billion.

In the United States, aflatoxins are not commonly cited as a reason for import "refusals" by the Food and Drug Administration (FDA), the Federal agency that enforces mycotoxin regulations. In 2001, only 4 of 1,781 FDA import detentions of cereals (grain) and cereal products (which include consumer-ready processed products) were due to aflatoxins, although detentions were more common for contamination of nut and seed imports. Nevertheless, several studies indicate that the economic costs of enforcing standards, and the lost trade opportunities stemming from unharmonized global product standards on mycotoxins, are substantial:

- One study estimated that crop losses (corn, wheat, and peanuts) from mycotoxin contamination in the United States amount to $932 million annually, in addition to losses averaging $466 million annually from regulatory enforcement, testing, and other quality control measures (CAST, 2003).
- Wilson and Otsuki (2001) estimated that, for a group of 46 countries—including the United States—the adoption of a uniform aflatoxin standard based on international Codex Alimentarius Commission (Codex) guidelines would increase trade of cereals (grains) and nuts by more than $6 billion, or more than 50 percent, compared with the divergent standards in effect during 1998.

There are several reasons why trade disputes related to the setting of regulatory standards on mycotoxins could persist, or even worsen. First, mycotoxin contamination is recognized as an unavoidable risk. Codex, for example, notes that many factors that influence the level of contamination in cereals and grains are environmental—such as weather and insect infestation—and therefore are difficult or impossible to control. Second, perceptions of tolerable health risks are not likely to narrow significantly in the near future since they appear to hinge largely on the level of economic development and the susceptibility of a nation's crops to contamination. Finally, under the "precautionary principle," some countries may set new standards on certain mycotoxins for which scientific evidence of a health risk is unclear.[2]

One strategy to lower both the health risks and the economic costs associated with mycotoxins is to increase awareness among food producers and handlers of practices which would minimize mycotoxin contamination, and to encourage the adoption of process-based guidelines such as good agricultural practices (GAPs) or good manufacturing practices (GMPs).


[1] Agricultural economist with the Market and Trade Economics Division, Economic Research Service, USDA.

[2] The "precautionary principle" is a term referring to the use of environmental or health precautions in situations where the extent or source of a particular risk is unclear.

## Introduction

Concerns about human health arise when grains and other field crops are found to contain unsafe chemicals, additives, or other contaminants. Many countries have established sanitary and phytosanitary (SPS) regulations to protect consumers from these health risks, while seeking to balance health benefits with the potential trade disruptions, economic losses, and market uncertainties that regulations can cause. Among grains and other field crops, perhaps the most prevalent—if publicly unrecognized—source of food-related health risks are naturally occurring poisonous substances called mycotoxins. Consuming grains or other foods contaminated with certain mycotoxins can be fatal if the toxins are present at very high levels. Long-term exposure to mycotoxins can increase cancer risk, and suppress the immune system, among other health problems.

Although humans face health risks stemming from the contamination of grains with other naturally occurring substances, mycotoxins are unique in that they are produced naturally on the grain, and their presence (at least initially) is usually associated with uncontrollable factors such as climatic conditions.[3] The presence of mycotoxins can also be distinguished from plant infestations that affect grains—such as TCK smut and Karnal bunt infestations which are still subject to SPS-related import controls designed to protect the quality of domestically produced crops—but pose no food safety risk.

Mycotoxins are produced by certain fungi (e.g., *Aspergillus* ssp., *Penicillium* ssp., and *Fusarium* ssp.) that grow on human food and animal feed ingredients such as corn, sorghum, wheat, barley, peanuts, and other legumes and oilseeds. Five broad groups of mycotoxins—aflatoxin, vomitoxin, ochratoxin A, fumonisin, and zearalenone—are commonly found in food and feed grains (table 6.1). Among mycotoxins, probably the most widely recognized risk comes from aflatoxins. Aflatoxins are extremely potent carcinogenic and mutagenic substances that first came into the public spotlight—and were formally identified—in the early 1960s following the deaths of more than 100,000 young turkeys on a poultry farm in England. The so-called Turkey X disease was eventually tied to high levels of aflatoxin in Brazilian peanut meal imported as a feed ingredient. Aflatoxin contamination is most common in African, Asian, and South American countries with warm and humid climates, but also occurs in temperate areas of North America and Europe. These five groups of mycotoxins all pose health concerns and are subject to SPS or other regulatory measures.

The fungi (mold) that produce mycotoxins can emerge either in the field (in soil, decaying vegetation, and grains undergoing microbiological deterioration) or during postharvest transportation or storage. Temperature stress is an important cause of fungi growth on crops in the field, and high moisture content (water activity) and temperature are associated with the growth of fungi in stored grain. Detection and control of the fungi is a continuous concern since the fungi can become established and remain with the commodity anywhere along the production, storage, transportation, and processing chain. A further concern is that the absence of visible mold does not guarantee the grain is free from mycotoxin, and cooking or processing the food product does not necessarily rid it of mycotoxin contamination. For example, molds contaminated with aflatoxins have been isolated in processed food products such as bread, macaroni, cooked meat, cheese, and flour (Guerzoni, 1999).

For the consumer, a food safety concern is potential exposure to mycotoxins through consumption of food from contaminated crops, which can produce acute and/or long-term health problems. Consuming food products that contain high levels of certain mycotoxins can cause the rapid onset of mycotoxicosis, a severe illness characterized by vomiting, abdominal pain, pulmonary edema, convulsions, coma, and in rare cases, death. Although lethal cases are uncommon, acute illnesses from mycotoxins, particularly aflatoxins (aflatoxicosis), have been reported from many parts of the world, usually in developing countries. Some notable outbreaks include the deaths of 3 Taiwanese in 1967, and the deaths of more than 100 people in Northwest India in 1974. Both outbreaks were attributed to aflatoxin contamination, of rice in Taiwan and corn in India. Vomitoxin was responsible for another large-scale incident of mycotoxicosis in India in 1988.

Although more difficult to directly associate with mycotoxin contamination, an equal, or perhaps even greater, food safety concern than acute illness is the long-term effects of lower-level mycotoxin consumption, particularly the risks of cancer and immune deficiency. Aflatoxin B1 was placed on the list of known human carcinogens by the International Agency for

[3] For example, dioxins also occur naturally—sometimes as a result of forest fires or volcanic eruptions—but they are often the byproduct of industrial processes (see chapter 8).

**Table 6.1—Common mycotoxins, commodity affected, and health effects**

| Mycotoxin | Commodities | Fungal source(s) | Effects of ingestion |
|---|---|---|---|
| Aflatoxin B1, B2 G1, G2 | Corn, peanuts, and many other commodities | *Aspergillus flavus* *Aspergillus parasiticus* | Aflatoxin B1 identified as potent human carcinogen by IARC.[1] Risk of human toxicosis. Adverse effects in various animals, especially chickens. |
| Deoxynivaleno[1] Nivalenol (Vomitoxin) | Wheat, corn, and barley | *Fusarium graminearum* *Fusarium crookwellense* *Fusarium culmorum* | Human toxicoses in India, China, Japan, and Korea. Toxic to animals, especially pigs. |
| Zearalenone | Corn, wheat | *Fusarium graminearum* *Fusarium culmorum* *Fusarium crookwellense* | Identified by the IARC as a possible carcinogen. Affects reproductive system in laboratory animals and pigs. |
| Ochratoxin A | Barley, wheat, and many other commodities | *Aspergillus ochraceus* *Penicillium verrucosum* | Suspected by IARC as human carcinogen. Carcinogenic in laboratory animals and pigs. |
| Fumonisin B1 | Corn | *Fusarium moniliforme* plus several less common species | Suspected by IARC as human carcinogen. Toxic to pigs and poultry. Cause of equine eucoencepha-lomalacia (ELEM), a fatal disease of horses. |

[1]International Agency for Research on Cancer.

Source: adapted from GASCA, "Mycotoxins in Grain." Group for Assistance on Systems Relating to Grain after Harvest. Technical Center for Agricultural and Rural Cooperation (CTA), the Netherlands, Technical Leaflet No. 3. 1997. *www.fao.org/inpho/vlibrary/x0008e/X0008E00.htm#Contents*.

Research on Cancer (IARC) in 1988, and other mycotoxins are suspected or known to be carcinogenic or to have other adverse health consequences (table 6.1).[4] Aflatoxins are a particular concern for populations with a high incidence of hepatitis B because the relative rate of liver cancer in people with hepatitis B is up to 60 times greater than normal when those people are exposed to aflatoxin (Miller, 1996, p. 4).

In addition to direct risks to humans from consumption of mycotoxin-contaminated grains, there are indirect health risks to those who consume animal products containing residues of carcinogenic mycotoxins. Mycotoxins can be detected in meat, milk, and eggs from animals that have consumed feed ingredients containing mycotoxins, and many countries have tolerance standards for mycotoxin residues in these products.

Another concern related to the consumption of mycotoxin-contaminated feed by livestock is the potential for economic losses from animal health and productivity problems. Aflatoxins in feed are known to be associated with liver damage in animals, reduced milk and egg production, poor weight gain, and recurrent infections due to immunity suppression. The young of any particular species are most vulnerable, but the degree of susceptibility varies by species.

## Regulatory Actions

As with many public food safety regulations, domestic and trade regimes governing mycotoxins in most countries take the form of product, rather than process, standards. That is, tolerance levels for the amount of mycotoxin in a product are established rather than regulating the production or treatment of the commodity along the marketing chain (Henson and Caswell, 1999).

The United States began regulating the concentration of mycotoxins in food and feed in 1968, following some of

[4] Specifically, "mycotoxins may be carcinogenic (e.g., aflatoxin B1, ochratoxin A, fumonisin B1), estrogenic (zearalenone and I and J zearalenols), nephrotoxic (ochratoxins, citrinin, oosporeine), dermonecrotic (trichothecenes), or immunosuppressive (aflatoxin B1, ochratoxin A, and T-2 toxin)…. Much of the published information on toxicity comes from studies in experimental animals, and these may not reflect the effects of mycotoxins on humans and other animals…. [Nevertheless] residues in animal products of carcinogenic mycotoxins, such as aflatoxin B1, M1, and ochratoxin A, pose a threat to human health, and their levels should be monitored" (Orriss, 1997, p. 2).

the early incidents of animal and human health problems related to mycotoxins. A study by the United Nations' Food and Agriculture Organization (FAO) on worldwide regulations for mycotoxins revealed that at least 77 countries now have specific regulations for mycotoxins. Thirteen countries are known to have no specific regulations, and no data are available for about 50 countries, many of them in Africa (Van Egmond, 1999).[5] Survey data by the FAO also reveal that the number of countries adopting mycotoxin regulations grew significantly from the mid-1980s to mid-1990s, and that the range of tolerance levels vary widely (Van Egmond, 1999). In 1996, for example, 48 countries had established tolerance levels for total aflatoxins in food—up from 30 in 1987—with standards ranging from 0 parts per billion (ppb) to 50 ppb. For the 21 countries with total aflatoxins standards on animal feeds, the tolerance levels ranged from 0 ppb to 1,000 ppb (table 6.2).

According to the Joint FAO/World Health Organization (WHO) Expert Committee on Food Additives (JECFA), the scientific body that develops advisory international standards on food additives and contaminants for the Codex Alimentarius Commission, reaching consensus on maximum levels for aflatoxin (and other mycotoxin) standards is complicated by the fact that:

> levels of contamination of foodstuffs vary tremendously around the world, and … with respect to trade, the perspectives of delegations differ profoundly. Those representing countries in which aflatoxin contamination is not prevalent want low standards because they do not wish to see the quality of their food supply degraded. Those delegations from countries in which aflatoxin contamination is a problem because of their climatic conditions naturally wish to have standards in which higher levels of contamination are permitted so that they can trade their products on world markets (Hermann, 1999, p. 3).

Thus, for a large number of countries, the risks associated with mycotoxin contamination are generally recognized and the levels entering the food chain subject to limitations. Enforcing these limitations naturally imposes costs on domestic producers and consumers (e.g., of monitoring, testing, destroying the crop or diverting it to lower valued use). At the same time, when the cost and benefit analyses—or risk assessments—underlying domestic regulations lead countries to set different tolerance standards, these divergent standards can also affect producers in other countries, disrupt trade, and result in trade disputes.

## U.S. Regulatory Provisions

In the United States, authority to regulate mycotoxins (i.e., aflatoxin, fumonisins, and vomitoxin) is established by the Federal Food, Drug and Cosmetic Act (FFDCA), which is enforced by the Food and Drug Administration (FDA). The FDA has established specific "action" levels for aflatoxin present in food or feed and "advisory" levels for other mycotoxins. The action and advisory levels are designed to provide an adequate margin of safety to protect human and animal health (Robens, 2001; USDA, 1998). The standard for aflatoxins is 20 ppb for human food and animal feeds (corn and other grains) intended for immature animals or unknown destinations. Except for mandatory aflatoxin testing on U.S. corn exports, however, mycotoxin testing for domestically produced or imported foods and feed ingredients is not required by law. That is, testing for mycotoxins in grains that are not exported is voluntary, and contamination levels are not considered part of official grading standards for agricultural commodities. The FDA does have a monitoring program, however, and "reserves the right to take appropriate enforcement actions when circumstances warrant such actions" (CAST, 2003, p. 109).

The U.S. Department of Agriculture's Grain Inspection, Packers and Stockyards Administration (GIPSA) also offers aflatoxin testing for corn, sorghum, wheat, and soybeans as "official criteria" under the United States Grain Standards Act, and has an official understanding with the FDA that it will report to them samples that exceed established action levels. In the event this occurs, any action by the FDA on a lot sample that tests above that level is taken on a case-by-case basis, and can involve diverting the commodity to alternative uses with less stringent standards (e.g., corn for ethanol production or "finishing" beef cattle), and will only rarely require disposal (table 6.3).

In addition, purchasers may regularly test grains as part of their routine quality control efforts (Lijewski, 2002), and contracts between buyer and seller may be contingent upon achieving an aflatoxin (or other mycotoxin)

[5] Most of the existing mycotoxin regulations concern aflatoxins in food, and in fact all countries with mycotoxin regulations at least have tolerances for aflatoxin B1 (considered the most toxic aflatoxin) or the sum of the aflatoxins B1, B2, G1, and G2 in foods and/or animal feed.

**Table 6.2—Medians and ranges of maximum aflatoxin tolerance levels and number of countries with regulations (1987, 1996)**

| Category | 1987 | | | 1996 | | |
|---|---|---|---|---|---|---|
| | Median | Range | No. of countries | Median | Range | No. of countries |
| | *— Parts per billion —* | | *Number* | *— Parts per billion —* | | *Number* |
| B1 in foodstuffs | 4 | 0-50 | 29 | 4 | 0-30 | 33 |
| B1+B2+G1+G2 in foodstuffs | 7 | 0-50 | 30 | 8 | 0-50 | 48 |
| B1 in foodstuffs for children | 0.2 | 0-5.0 | 4 | 0.3 | 0-5.0 | 5 |
| M1 in milk | 0.05 | 0-1.0 | 13 | 0.05 | 0-1.0 | 17 |
| B1 in feedstuffs | 30 | 5-1,000 | 16 | 20 | 5-1,000 | 19 |
| B1+B2+G1+G2 in feedstuffs | 50 | 10-1,000 | 8 | 50 | 0-1,000 | 21 |

Source: Adapted from Van Egmond, Hans, "Worldwide Regulations for Mycotoxins." Third Joint FAO/WHO/UNEP International Conference on Mycotoxins. MYC-CONF/99/8a, March 1999.

**Table 6.3—Product standards for aflatoxins (United States, European Union, and Codex Alimentarius)**

| United States[1] | | European Union[2] | |
|---|---|---|---|
| Product | Standard | Product | Standard |
| | *Parts per billion* | | *Parts per billion* |
| Raw peanuts (industry standard). | 15 | Peanuts, nuts, dried fruit, and processed products thereof, intended for direct human consumption. | 4 (2) |
| Human food, corn, and other grains intended for immature animals (including poultry) and for dairy animals or when its destination is not known. | 20 | Peanuts to be subjected to sorting or other physical treatment, before human consumption or use as an ingredient in food. | 15 (8) |
| For animal feeds, other than corn or cottonseed meal. | 20 | Nuts and dried fruit to be subjected to sorting or other physical treatment, before human consumption or use as an ingredient in food. | 10 (5) |
| For corn and other grains intended for breeding beef cattle, breeding swine, or mature poultry. | 100 | Cereals and processed products thereof intended for direct human consumption or an ingredient in food. | 4 (2) |
| For corn and other grains intended for finishing swine of 100 pounds or greater. | 200 | | |
| | | Feed materials and complete feedstuffs with the exception of:[3] | (50) |
| For corn and other grains intended for finishing beef cattle and for cottonseed meal intended for cattle, swine, or poultry. | 300 | - feed materials from peanuts, copra, palm-kernel, cottonseed, corn and products processed thereof, | (20) |
| | | - complete feedstuffs for dairy cattle | (5) |
| | | - complete feedstuffs for pigs and poultry (except young animals) | (20) |
| **Codex** | | | |
| Peanuts intended for further processing. | 15 | - other complete feedstuffs. | (10) |

[1] Food and Drug Administration (FDA) standard unless otherwise noted.
[2] Numbers in parentheses refer to separate standard for aflatoxin B1 alone.
[3] Additional standards exist for "complementary feedingstuffs."
Sources: USDA (GIPSA), 1998; Otsuki et al., 2001; EC, 1999.

level at, or even below, FDA-established action or advisory levels.[6] According to a private commodity analyst, most grain purchase contracts of corn processors specify aflatoxin levels below the FDA standard, often 10 ppb or less (Brenner, 2002). Under industry guidelines developed by the U.S. Peanut Administrative Committee, mandatory testing and a separate industry standard of 15 ppb does exist for aflatoxins in raw peanuts.

Testing for aflatoxins in imported foods is not required, but the FDA does test samples of food and feed imports on a regular basis, and import refusals are authorized under the FFDCA. Between 1987 and 1997, the FDA inspected an average of about 500 samples of imported foods and feed per year for aflatoxins, with about 4 percent of samples testing above the 20 ppb level, almost exclusively in food products (CAST, 2003, p. 43). In 2001, the FDA recorded more than 2,100 detentions of imported cereals (grains), cereal products, nuts, and seeds due to food safety concerns, although just 29 of the detentions were due to aflatoxins.

## Multinational Standard Setting and the SPS Agreement

At the international level, the Codex Alimentarius Commission of the United Nations (henceforth "Codex") has, since 1963, developed general principles of food safety and hygiene designed to promote food safety and facilitate trade, including the setting of advisory standards on natural and environmental toxins such as mycotoxins (FAO, 2002).

Codex standards are advisory, not mandatory, and the data in table 6.2 demonstrate that national standards vary widely, with aflatoxin standards for foods fluctuating from zero tolerance to more than three times the Codex standard of 15 ppb.[7] Nevertheless, within the regulatory framework of the World Trade Organization (WTO), the Sanitary and Phytosanitary (SPS) Agreement—while not ceding authority over food safety standards from national governments—maintains that measures which conform to Codex standards, guidelines, or other recommendations are science-based, appropriate, and nondiscriminatory (Park et al., 1999).

Henson and Caswell (1999) point out that the SPS agreement essentially requires WTO members to justify the food safety regulations that they apply and demonstrate that any trade distortive effects (costs) are proportionate to the potential health benefits. Food safety regulations can be justified either by simply adopting international standards (i.e., Codex standards), which are assumed to be unchallengeable, or by conducting a scientific risk assessment of the health concerns addressed by the food safety regulation.[8]

Thus, the SPS agreement represents an effort to promote transparency in the establishment of food safety regulations and, if possible, to harmonize regulations based on sound risk assessment principles. Ultimately, the goal is to facilitate trade without compromising consumer protection.

However, the idea that there can be a uniform assessment of how to balance human safety concerns with "proportionate" impacts on trade can be both problematic and controversial. Some argue that food safety regulations, particularly standards stricter than those proposed by Codex, impose unfair economic, and even safety, burdens on lower-income food exporting countries. The argument is that such standards limit export opportunities because compliance is either too costly or unachievable given a lack of technical capacity, infrastructure, and food hazard management experience. Stricter regulations in importing countries are even cited as an additional health risk burden on the exporting country population since only the best quality foods leave the country, leaving commodities with higher levels of mycotoxin contamination for the domestic population (Cardwell et al., 2001).

[6] Testing is also provided for processed products such as corn meal, corn gluten meal, corn/soy blend, popcorn, rice, and other products governed by the Agricultural Marketing Act of 1946.

[7] It should be noted that the only crop for which Codex has adopted a mycotoxin standard is peanuts, with a total aflatoxin (B1+B2+G1+G2) standard of 15 ppb. Codex has also established a standard for aflatoxin M1 in milk and a 50 ppb standard for the mycotoxin patulin in apple juice and apple juice ingredients. It is also considering a proposed maximum of 5 ppb for ochratoxin A in raw wheat, barley, rye, and derived products.

[8] The adoption of stricter standards than those prescribed by the Codex Alimentarius to achieve a lower level of risk is allowed under the SPS agreement, but according to Henson and Caswell (1999, p. 599), the setting of national standards are supposed to meet certain criteria. Risk assessment should involve generally recognized techniques, must be supported by currently available scientific evidence (or "pertinent information"), must demonstrate that the level of protection is appropriate given the level of risk that the country aims to achieve, and must show that actions taken to achieve the desired level of protection do not impede trade unnecessarily.

## Economic Impact on International Trade

The economic losses associated with mycotoxin contamination are difficult to assess in a consistent and uniform way, and no comprehensive analysis of the costs to U.S. and foreign crop and livestock producers is available. The lack of information on the health costs and other economic losses from mycotoxin-induced human illness is partly due to the difficulty of establishing cause-and-effect relationships between the mycotoxins and the chronic diseases they are suspected of causing. However, with an estimated 25 percent to 50 percent (Miller, 1995) of the world's food crops affected by mycotoxins, the economic costs are likely to be considerable.[9] Numerous reports focusing on different countries/regions, commodities, toxins, and cost categories (e.g., costs of regulations, testing, production loss, trade losses) offer some indication of these losses.

For the United States, one study using FDA sample data and computer simulations estimated that crop losses from mycotoxin (aflatoxin, fumonisin, and deoxynivalenol) contamination of corn, wheat, and peanuts averaged $932 million annually (CAST, 2003). Additional losses averaging $466 million stem from efforts to prevent or reduce contamination (through regulatory enforcement, testing, and other quality control efforts). In this study, livestock losses were estimated at only $6 million annually. However, an earlier report estimated that, in some years, production losses to the U.S. poultry and swine industries have surpassed $100 million (CAST, 1989).

Numerous other reports of economic losses to specific commodities in selected years—due to complete loss of the crop value or diversion into discounted markets such as feed or ethanol use—indicate that for the U.S., economic losses from mycotoxins are primarily confined to domestic crop producers and their potential downstream users, including export markets.[10]

[9] Alternatively, Park et al. (1995) estimate that the actual global production of commodities at "high risk," including corn, peanuts, copra, palm nuts, and oil seed meal, comes to about 100 million metric tons, a significant but smaller proportion of global production than cited by Miller (1995).

[10] Some other examples of estimated losses in the U.S. include: peanuts - $25 million/year (1993-96); cottonseed - $20-$50 per ton discount (Arizona); barley - $406 million between 1993 and 1998 (Minnesota, N. Dakota, S. Dakota); wheat - $300 million (1996) in Red River Valley (Minnesota, N. Dakota, S. Dakota) (Robens, 2001).

As for imports into the United States, data on import refusals by the FDA during 2001 reveal that the presence of aflatoxins was not a commonly invoked reason for detaining food product imports into the United States that year—because contaminated products were detected and diverted to other uses before exportation, or perhaps because the U.S. does not import a large volume of products most susceptible to aflatoxins (e.g., peanuts or corn). In 2001, there were 1,781 import detentions of cereals (grain) and cereal products (which include consumer-ready processed products), and another 387 detentions of nuts and edible seeds. However, only 29 of the detentions were due to aflatoxins, only 4 in the cereal and cereal product category. Of the 1,781 detentions in this category, only 52 were due to "naturally occurring" safety concerns (other than "filth"): 47 detentions for *Salmonella*, 4 for aflatoxins, and 1 for *Listeria*. The majority of detentions were due to labeling or branding issues, or the presence of unsafe additives.

For developing countries, lost export opportunities to developed countries—which typically have more stringent mycotoxin limitations—appear significant. The potential for disruptions to developing-country food exports resulting from regulatory actions in high income markets is underscored by the fact that the majority—nearly 70 percent—of developing Middle East and African country food exports are destined for high-income countries.[11]

In some cases, developing countries have experienced market losses due to persistent mycotoxin problems or the imposition of new, stricter regulations by importing countries. Thailand was once among the world's leading corn exporters, regularly ranking among the top five exporters during the 1970s and 1980s. But partly due to aflatoxin problems, Thai corn regularly sold at a discount on international markets, costing Thailand about $50 million per year in lost export value (Tangthirasunan, 1998). According to FAO estimates, the direct costs of mycotoxin contamination of corn and peanuts in Southeast Asia (Thailand, Indonesia, and the Philippines) amounted to several hundred million dollars annually, with most of the losses accounted for by corn (Bhat and Vasanthi, 1999). India also saw exports of peanut meal to the European Union (EU) drop by more than $30 million a year when the EU imposed new mycotoxin regulations in the early 1980s (Bhat and

[11] Otsuki et al., 2001. Data are from the mid-1990s. Only 16 percent of Middle East and African country food trade was intraregional.

Vasanthi, 1999). Total peanut meal imports by the current 15 EU member countries fell from over 1 million tons in the mid-1970s to just 200,000-400,000 tons annually after 1982.

## Balancing Food Safety Costs and Benefits From Trade: The Case of EU Mycotoxin Regulations

Several recent studies have helped to crystallize the fact that the setting of tolerance levels for mycotoxins involves clear, but controversial, tradeoffs between human health and economic opportunity. One study measured the potential health impacts on cancer death rates from the adoption of two alternative standards for aflatoxin. Motivated by a proposed harmonization of EU mycotoxin standards at a level lower (more stringent) than advisory standards set by Codex Alimentarius, several other studies looked at the trade impacts of different aflatoxin standard harmonization scenarios.

In 1997, the JECFA—which provides scientific advice to Codex—evaluated the potential risks of aflatoxins and considered the possible impact of two alternative aflatoxin standards (10 and 20 ppb) on human health. Two examples were developed, a European diet with 1 percent of the population testing positive for hepatitis and a Far Eastern diet with 25 percent testing positive for hepatitis. The JECFA study concluded that, for the first example (European diet), implementation of a 20-ppb standard would lead to a risk of 41 cancer deaths per year per 1 billion persons. Adoption of the lower 10-ppb standard would reduce the risk to 39 cancer deaths per year per 1 billion persons, or 2 lives per year for a population of 1 billion persons. The same change in standards would lower cancer deaths by about 300 persons per year per 1 billion people for the Asian diet (and high incidence of hepatitis) scenario (Herrman and Walker, 1999).

Also in 1997, the EU proposed a new harmonized standard for aflatoxins, provoking a number of complaints by nonmember countries. The proposal recommended establishing a standard of 4 ppb of total aflatoxins (B1+B2+G1+G2)—2 ppb for B1 alone—in cereals (grains), edible nuts, dried and preserved fruits, and groundnuts (peanuts) intended for direct human consumption. This level represented a stricter standard than the standards in effect in most EU countries at the time, and considerably lower than Codex recommendations and standards in many developing countries (table 6.3). Codex, for example, has a recommended standard of 15 ppb for total aflatoxins in peanuts, and the average African standard for peanuts was as high as 44 ppb—14 ppb for aflatoxin B1 (Otsuki et al., 2001).

The originally proposed standard was relaxed for some categories of use following complaints by Argentina, Australia, Bolivia, Brazil, Canada, India, Mexico, Pakistan, Peru, and Uruguay. These countries argued that "the EC [European Commission] requirements not only departed from the Codex Alimentarius recommendations, but also had considerable social and economic impacts on the concerned countries" (WTO, 1998, p. 3). The subsequently proposed standards, implemented in March 2001 (and amended in 2002), were nevertheless still more stringent than those previously in place for eight of the EU countries, and the standards for cereals and nuts intended for direct human consumption were not relaxed from the originally proposed level (Otsuki et al., 2001).

A widely cited journal article by Otsuki et al. (2001) found that cereal (and cereal preparations) exports by 9 African countries to the EU during 1998 would have declined by 59 percent, or $177 million, if the EU had harmonized their aflatoxin regulations at the proposed limit and enforced this limit on all shipments. Alternatively, the adoption of the somewhat more lax Codex standard by the EU would increase the African country cereal (and preparations) exports to the EU by $202 million, a 68-percent increase. For edible nuts and dried and preserved fruits, the estimated decline in African exports to the EU would be $220 million (47 percent) if the EU harmonized its regulations at the proposed level, but would increase $66 million (14 percent) if the Codex standard was adopted.

Another study by the World Bank (Wilson and Otsuki, 2001) broadened the analysis to evaluate the impact on grain and tree nut trade among 15 importing and 31 exporting countries, including the United States. Among the countries studied, the uniform adoption of a Codex standard of 9 ppb for aflatoxin B1 would increase cereal and nut trade by $6.14 billion, or more than 50 percent, compared with the (1998) status quo.[12]

[12] The study assumes that, for all cereals and nuts, the countries would adopt standards based on the current Codex advisory standard for peanuts. The Codex standard for peanuts is 15 ppb for all aflatoxins combined, but Wilson and Otsuki assume that aflatoxin B1 comprises, on average, about 60 percent of the total level of aflatoxin contamination (or about 9 ppb).

The impact on the United States would amount to more than $700 million in increased exports.[13]

Similarly, adoption of a proposed European Union standard of 2 ppb for aflatoxin B1 by all countries included in the study would reduce trade by $6.05 billion, compared with status quo regulations. The results also show that, since less developed countries generally have less stringent standards for aflatoxin, less developed countries that conduct trade with one another will lose more export opportunities than developed countries. Under a scenario where all countries adopt a uniform standard that maintains global trade at baseline (1998) levels, the distribution of trade shifts to favor developed-country exports and reduces less developed country exports by 10 percent.

## Process Standards Complement Product Standards and Can Accomplish Similar Goals

The studies cited earlier clearly illustrate that food safety regulations—particularly product standards such as specific tolerance levels—have significant economic consequences, and that different perceptions about appropriate tradeoffs between health and economic losses are the source of potential conflict between countries. With this in mind, what strategies can be used to diffuse trade frictions, and at the same time help reduce economic losses from mycotoxin contamination and divergent standards?

A common method of minimizing food safety risks is the adoption of good agricultural practices (GAPs) at the preharvest level and good manufacturing practices (GMPs) at the processing and distribution stages. These strategies—implemented independently by private groups, or required by public agencies—can be used to control and minimize risk throughout the production, handling, and processing chain. These can complement product standards, and potentially reduce overall economic losses. In the United States, for example, a standard practice among grain processors is to clean corn before any manufacturing process in order to sift out broken kernels and screenings that are more susceptible to mycotoxin infestation. Grain purchasers also conduct a regular program of testing following harvest to determine whether there are any mycotoxin problems in particular supply areas (Brenner, 2002).

In its 34th session held in March 2002, a Codex Committee on Food Additives and Contaminants (CCFAC) report recommended that GAPs and GMPs be used to establish formal hazard analysis and critical control point (HACCP) food safety systems to identify, monitor, and control mycotoxin risks all along the food production chain (Codex, 2002). Park et al. (1999) suggest steps that can be taken at five stages of food production to lower mycotoxin contamination. At the preharvest stage, for example, insect control, adequate irrigation, crop rotation, and other practices can help minimize initial contamination in the field (table 6.4). During storage, properly dried crops should be protected from moisture, insects and rodents, and monitored for temperature, moisture, and humidity changes. Electronic or hand-sorting can be conducted before processing.

HACCP principles are thus likely to be among the most effective means of lowering risks and economic losses, especially since prevention of mycotoxin contamination is widely considered more practicable than decontamination.[14] However, an effective long-term strategy for controlling and monitoring mycotoxin risks in developing countries most susceptible to the problem may require technical assistance from public agencies and improved adherence to quality control measures and HACCP principles by private actors. In India, for example, one report noted that more than one-quarter of tested corn samples exceeded the Indian tolerance limit of 30 ppb, and that if Codex standards were applied, nearly one-half (47 percent) of the samples would have to be rejected (Van Egmond, 1995, in Bhat and Vasanthi, 1999)—indicating high levels of contamination most likely caused by improper drying or storage.

[13] This compares to a survey-based estimate that places the impact of "questionable" SPS-related food safety regulations on U.S. agricultural exports at $2.29 billion. Of this, $1.02 billion of the trade impact was to grain and feed grains, with "the Americas" accounting for the major share (69 percent) of the losses, followed by East Asia (14 percent), Europe (11 percent), and Africa (6 percent). No information on the specific nature of the SPS barriers was given (Thornsbury et al., 1997).

[14] According to Codex (1997), "to date there has been no widespread government acceptance of any decontamination treatment intended to reduce aflatoxin B1 levels in contaminated animal feedingstuffs."

**Table 6.4—Possible HACCP application stages for agricultural commodities, food products, and animal feeds**

| Stage | Commodity | Hazard | Corrective action |
|---|---|---|---|
| Preharvest | Cereal grains, oil seeds, nuts, fruits | Mold infestation with subsequent mycotoxin formation | -use crop resistant varieties<br>-enforce effective insect control programs<br>-maintain adequate irrigation schedules<br>-perform good tillage, crop rotation, weed control, etc. |
| Harvesting | Cereal grains, oil seeds, nuts, fruits | Increase in mycotoxin formation | -harvest at appropriate time<br>-maintain at lower temperature, if possible<br>-remove extraneous material<br>-dry rapidly to below 10 percent moisture. |
| Postharvest, storage | Cereal grains, oil seeds, nuts, fruits | Increase and/or occurrence of mycotoxin | -protect stored product from moisture, insects, environmental factors, etc.<br>-store product on dry, clean surface. |
| Post-harvest, processing and manufacturing | Cereal grains, oil seeds, nuts, fruits | Mycotoxin carryover or contamination | -test all ingredients added<br>-monitor processing/manufacturing operation to maintain high-quality product<br>-follow good manufacturing practices. |
| Animal feeding | Dairy, meat and poultry products | Transfer of mycotoxin to dairy products, meat and poultry products | -monitor mycotoxin levels in feed ingredients<br>-test products for mycotoxin residues. |

Source: Park, Douglas, H. Njapau, and E. Boutrif. "Minimising [sic] Risks Posed by Mycotoxins Utilising [sic] the HACCP Concept." Third Joint FAO/WHO/NEP International Conference on Mycotoxins, Tunis, Tunisia. MYC-CONF/99/8b, 1999.

## Conclusion

Although not publicly prominent, food safety issues related to international trade in cereals and grains and other crops—particularly those pertaining to mycotoxin regulations—are economically important. Most countries do recognize that placing standards on the level of mycotoxins entering the food chain is prudent, but diverging perceptions of how to balance economic costs and health benefits have become a source of trade friction between countries. For export-reliant developing countries lacking the means to implement stronger quality control measures, the issue is especially relevant.

For several reasons, trade disputes related to the setting of regulatory standards on mycotoxins are likely to persist. First, mycotoxin contamination is recognized as an unavoidable risk. Codex (2002) notes that, in the field, many factors that influence the level of contamination in cereals and grains are environmentally related—such as weather and insect infestation—and are therefore difficult or impossible to control. Second, perceptions of tolerable health risks are not likely to narrow significantly in the near future since they appear to hinge largely on the level of economic development and the susceptibility of a nation's crops to contamination. Finally, using the precautionary principle, some countries may set new mycotoxin standards which lack internationally accepted risk assessments.

To minimize the initial risk of mycotoxin contamination and consequently lessen the likelihood that tolerance levels will be exceeded, private sector actors or public agencies can consider implementing process standards based on GAPs, GMPs, and HACCP principles. Developing countries are likely to require technical assistance and economic support to implement these strategies.

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*Chapter 7*

# International Trade and Seafood Safety

Jane Allshouse, Jean C. Buzby, David Harvey, and David Zorn[1]

## Summary

Seafood safety, in relation to international trade, is particularly important to the United States for several key reasons. U.S. per capita fish consumption has increased more than 50 percent since 1980 and is projected to continue increasing over the next 20 years (Blisard et al., 2002). Also, imports' share of total U.S. fish consumption now accounts for more than 75 percent of total consumption, compared with less than 50 percent in 1980. Finally, an increasing number of countries are exporting seafood to the United States and some of these countries have poor internal control systems and/or are in tropical areas where toxin and bacteria hazards are intrinsically higher (Ahmed, 1991).

The U.S. Food and Drug Administration (FDA) detains and inspects samples of imported seafood at the port of entry and refuses adulterated shipments. The 2001 FDA import detention data for seafood products indicates that out of 130 countries represented, 80 had violations for adulteration (safety, packaging integrity, or sanitation problems). Detention rates in terms of value were low, with an average of 0.46 detentions per $1 million of imports. Of the 6,405 violations, 84 percent were for adulteration, with *Salmonella* accounting for 34 percent of all adulteration violations. Shrimp, by far the largest import item, accounted for one-quarter of all detentions.

Public and private entities are using measures to ensure safer seafood in addition to end product testing and inspection. Hazard analysis and critical control point (HACCP) systems have been implemented increasingly by private industry for seafood, sometimes voluntarily and sometimes as mandated by Federal governments. Other actions being taken include investment in new technologies and equipment and in identity preservation systems.

As most contamination problems are from *Salmonella* in shrimp and prawns, risk reduction efforts theoretically could be focused on that bacterium. Shrimp is primarily an aquaculture product, so improvements in sanitation and production practices perhaps could make substantial differences in the occurrence and extent of *Salmonella* contamination. However, for the foreseeable future, shrimp will continue to be produced primarily by developing nations and dominate seafood trade moving from developing nations to developed nations (Wessells, 2002). One hurdle is that many less developed countries have difficulty meeting developed countries' quality and safety standards because of a lack of sufficient funds to invest in quality control measures, more adequately trained staff, and expensive equipment (Rahman, 2001).

Continued growth in international seafood markets may increase market segmentation where wealthy countries demand higher valued seafood products with food safety ensured, while less wealthy countries consume lower value species with fewer safety assurances (Wessells, 2002). This means that the degree of food safety could become, to some extent, a source of product differentiation.

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# Introduction

There have been several major developments affecting international seafood trade since the 1970s. Most importantly, during 1976-78, the jurisdiction over coastal waters by coastal nations was expanded to 200 nautical miles offshore. This changed which countries imported or exported particular types of seafood (Wessells and Wallström, 1994). In essence, while most oceans remain a common property resource, nations have limited privatization giving them some control over maintaining fish stocks and determining appropriate levels and procedures for harvest (Wessells and Wallström, 1994). Also, technological advances in fishery operations have increased productivity and in turn altered patterns of trade. These advances have at the same time added pressures on wild fish stocks, which are inherently finite.

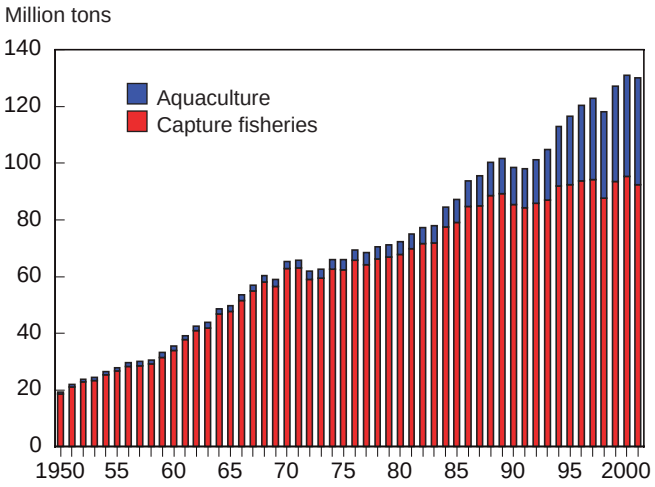
Another development is the considerable growth in aquaculture to supplement wild harvests. In the United States alone, aquaculture production increased from 570 million pounds in 1990 to 880 million pounds in 2000 (National Marine Fisheries Service, 2001). Similar growth can be seen in the aquaculture share of world fish and seafood production (fig. 7.1). Aquaculture has caused trade friction in instances where it has led to an oversupply of certain species, resulting in drastically reduced prices and charges of "dumping" of product (e.g., charges by the U.S. International Trade Commission that Norway dumped salmon into the U.S. market in 1989). Meanwhile, governments, particularly in developed countries, are increasingly recognizing the importance of monitoring the state of aquatic ecosystems and managing human interventions (FAO, 2000). Two widely publicized marine resource management examples are import restrictions on tuna harvested with methods that do not minimize dolphin bycatch and shrimp harvested in nets without turtle-excluder devices. Although international disputes for seafood can arise from different stances on jurisdiction, marine resource management, and aquaculture, the focus here is on seafood safety and international trade. In general, countries are increasingly concerned about seafood safety, particularly as trading patterns shift among developed and developing countries.

The United States is one of the world's largest producers, exporters, and importers of fish and fishery products. According to the Food and Agriculture Organization's (FAO) 2000 statistics, the United States ranked fifth in terms of volume of overall fisheries production (aquaculture and wild catch together), fourth in terms of volume of exports, and second in terms of volume of overall imports. Figure 7.2 shows that the total amount of seafood imported into the United States has been increasing over time. At the same time, the level of U.S. seafood exports has been sustained.

In relation to international trade, seafood safety is particularly important to the United States for several reasons. First, fish consumption has increased over 50 percent since 1980 and a USDA study projects continued increases over the next 20 years (Blisard et al., 2002). Second, the average import share of total U.S. consumption for fish and shellfish is increasing. It was

Figure 7.1

**World production from capture fisheries and aquaculture**

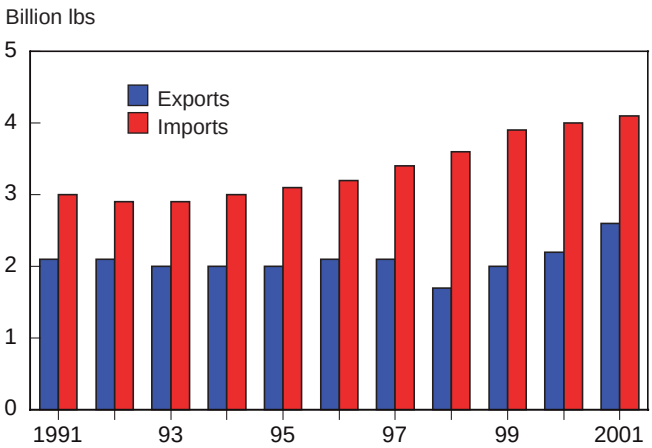



Note: Aquaculture quantities prior to 1984 are estimates.

Source: FAO, 2000.

Figure 7.2

**Volume of U.S. exports and imports of edible seafood, 1991-2001**




Source: NMFS, 2002.

56.3 percent in 1990 and 68.3 percent in 2000. Although there is no evidence that imported food, as a whole, poses higher food safety risks than domestically produced food (Zepp et al., 1998), the FDA has less direct access to food safety information on foreign seafood production and processing practices. Third, an increasing number of countries are exporting seafood to the United States and some of these countries have poor internal control systems and/or are in tropical areas where toxin and bacteria hazards are intrinsically higher (Ahmed, 1991). Fourth, FDA import detentions for "fishery/seafood products" accounted for almost 27 percent of the total number of detentions in 2001, second only to the "vegetable/vegetable products" category. Fifth, the large proportion of imported seafood raises concerns about potential food security concerns. Our heavy reliance on imported seafood means that any significant concerns over seafood safety have the potential to disrupt the flow of trade, reduce supplies to consumers, and limit sales for producers. Combined, these factors suggest that ensuring seafood safety is a task that will become more difficult.

FDA detains and inspects samples of imported seafood at the port of entry, refuses adulterated shipments, inspects foreign processors who wish to export to the United States, and inspects seafood importers in the United States. The Federal agency that governs fishery resources is the National Marine Fisheries Service (NMFS) in the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). A brief discussion is presented of some of the implications for policymakers. Seafood trade, in general, is complex because of diverse harvest methods, production areas, and markets, and because fish is not a homogenous commodity (Wessells and Wallström, 1994). Therefore, seafood safety issues are complex.

## U.S. Seafood Exports and Imports

In 2000, the U.S. fish and fishery harvest was estimated at 9.1 billion pounds (edible and nonedible), having peaked in 1993 and 1994 at just over 10 billion pounds. The domestic catch is composed of a large number of fish, shellfish, mollusk, and crustacean species, but a handful of species dominate the catch. The total landings (catch) of cod, flounder, menhaden, pollock, salmon, crab, shrimp, and squid accounted for 6.9 billion pounds, or 76 percent of the total catch in 2000.[2] The value of this total harvest was estimated at $3.5 billion (see box 7.1).

The United States is a major producer and exporter of fish and fishery products, on a value basis, but the United States imported roughly $6.8 billion more edible seafood than it exported in 2001: the U.S. imported $9.9 billion (4.1 million pounds) and exported $3.2 billion (2.6 million pounds) (NMFS, 2002) (fig 7.3).[3] Imports and exports are relatively similar to the domestic harvest in that a small number of species dominate the trade picture. Shrimp products made up the largest single import item. Imported shrimp products alone were estimated at 883 million pounds and were estimated to be worth $3.6 billion. The four species next in importance in terms of import values were tuna ($829 million), lobster ($728 million), crab ($368 million), and fresh and frozen salmon ($335 million). This would place the combined values of these products at $5.9 billion, or 60 percent of the value of all U.S. fisheries imports.

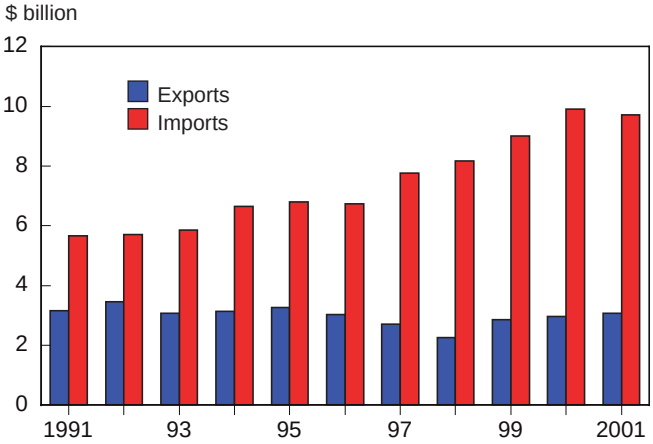
In general, seafood trade with the United States is less restricted than trade for other agricultural products and has no heavy quotas or duties on imports. The vast majority of seafood products are tariff free. Probably the

[2] Menhaden was probably mostly for industrial uses such as to make fish oil and meal for poultry feed.

[3] In 2001, the United States imported a total of roughly $18.5 billion in seafood, of which $8.7 billion was for nonedible seafood, and exported roughly $11.8 billion of seafood, of which $8.6 billion was nonedible.

Figure 7.3

**Value of U.S. exports and imports of edible seafood, 1991-2001**




Source: NMFS, 2002.

## Box 7.1—Measuring the monetary value of seafood

When using monetary values to measure production, imports, and exports, values are not all estimated at the same stage of production. Export value is the "free alongside ship" value, or the value of the product at the port of export, based on the sales price including inland freight, insurance, and other charges incurred prior to exportation. Production values are typically ex-vessel prices, that is, the value of the catch at the dock where the vessel is offloading. Also, export values per pound from the United States are usually significantly lower than import values per pound to the U.S. This is because the mix of species exported is different than the mix of species imported, and because the level of processing varies. Some of the seafood exported from the United States is low value-added or low value, whereas, a large percentage of the seafood imported to the United States is high value-added (e.g., filets) or high-value (e.g., shrimp). In fact, a significant quantity of seafood produced in the United States is exported to countries with significantly lower labor costs for processing and then reimported into the United States for consumption. This is part of the explanation of how the same country could be both a major importer and exporter of seafood. Lower labor costs and manageable transportation costs permit firms to profitably exchange substantial quantities of seafood in international commerce and still provide consumers with high quality seafood at affordable prices.

The other part of the explanation for countries being both importers and exporters of seafood is that harvests of seafood, like that of most agricultural commodities, are seasonal. Seafood producers use their access to international markets to stabilize their revenues. When a given species is in season in one country, some of the catch can be exported to other countries where that same species is out of season.

Therefore, both seafood producers and consumers have an interest in maintaining open markets for international trade to provide an almost year-round supply of seafood to as many potential customers as possible. If this is to be the case, then issues of seafood safety must be addressed and controlled as they arise.

best example of imports that enter the country with no tariff is frozen shell-on, head-off shrimp. This is the most common product form of imported shrimp and accounted for almost $3 billion in imports in 2001. Imports of fresh or frozen Atlantic salmon, either as whole fish or fillets, also enter with no tariff. The highest tariff rates on seafood imports were for tuna in an airtight container in oil (35 percent) and sturgeon roe/caviar (7.5 percent) (Koplin, 2002). One explanation for the lack of tariffs or very low tariff rates on most seafood is that traditionally imported seafood were products not available from local fishermen or not available in sufficient quantities. Additionally, restrictions may have lessened over time due to General Agreement on Tariffs and Trade (GATT) negotiations.

The United States imports seafood from many countries. The largest suppliers of seafood to the United States tend to be large producers of the top four seafood imports by value (i.e., shrimp, crab, salmon, and tuna). In 2001, Canada and Thailand were by far the largest suppliers, followed by China, Mexico, Chile, Vietnam, and Ecuador. Developing countries supply about half of all seafood exported worldwide (Sun and Caswell, 2002), and Asia is the leading region in seafood exports, with 36.5 percent of the total (Cato, 1998).

U.S. seafood exports are dominated primarily by shipments of salmon products, surimi, lobster, caviar (i.e., sturgeon roe), and other roe. U.S. seafood exports was sold primarily to Japan and Canada. These two countries accounted for almost 55 percent of export value in 2001. In particular, Pacific salmon harvested by the United States and not consumed in the western States is generally exported in large quantities to Japan. Meanwhile, the U.S. imports large amounts of farmed Atlantic salmon from Canada and Chile for consumption on the East Coast. Surimi, a processed seafood product, uses pollock as the major ingredient. The roe exports are a combination of products from herring, salmon, pollock, sea urchin, and other species.

## Seafood Safety

Seafood is processed into a wide range of products and is consumed in many forms (e.g., smoked, canned, salted, dried, fresh, frozen, and raw). While thorough cooking destroys most harmful organisms if any are present, raw oysters and clams have been popular in the United States and these products have been linked to ill-

ness from *Vibrio vulnificus* and other pathogens.[4] The 1998 FDA Food Safety Survey of U.S. adults found that 12 percent said they ate raw oysters (Fein and Riggins, 1998). Most seafood-associated illness reported by U.S. consumers point to consumption of raw bivalve mollusks and to unspecified and unknown foodborne illnesses with Norwalk-like viral gastroenteritis symptoms (Ahmed, 1991).

A National Academy of Sciences report indicates that most of the seafood sold in the United States is wholesome and unlikely to cause illness (Ahmed, 1991). However, some unknown portion of the estimated 76 million foodborne illnesses that occur each year in the United States (Mead et al., 1999) are attributed to seafood. According to the U.S. Centers for Disease Control and Prevention (CDC), surveillance data for foodborne disease outbreaks indicates that 6.8 percent of the 2,751 outbreaks during 1993-97 were attributed to consumption of shellfish and other fish (Olsen et al., 2000). However, these data do not capture unreported outbreaks or sporadic cases of foodborne illness, and so the true share of foodborne illness due to contaminated seafood is unknown.

On a global scale, the extent of illness from contaminated seafood is high. The World Health Organization (WHO) estimates that 40 million people become infected each year from trematode parasites by consuming raw or inadequately processed shellfish, freshwater fish, and aquatic plants (WHO, 1995). Data are not available on the extent of foodborne illnesses worldwide from all types of seafood hazards, which include:

- ***Bacteria***. A number of different bacteria potentially can be found in seafood. Some examples are *Vibrio parahaemolyticus*, *Listeria*, *Salmonella*, and *Staphylococcus*.
- ***Viruses***. Illnesses from viruses, such as the Norwalk virus, can be associated with the consumption of shellfish, particularly raw shellfish.
- ***Toxins***. Some naturally occurring toxins can accumulate in fish and mollusks. Examples include ciguatera found in some large tropical reef fish; domoic acid found in shellfish and mollusks; saxitoxin, also found in shellfish; and histamine in dolphin (i.e., mahi) and tuna.
- ***Parasites***. A number of fish species are at risk of having parasites such as roundworms. This normally becomes a human health problem only when fish are eaten raw or not fully cooked. The FDA Model Food Code requires freezing to destroy these organisms in fish for raw consumption.
- ***Chemicals***. Chemicals can be a localized problem in freshwater species, but can also affect ocean fish. Chemical contamination can result from local spills or dumping of pesticides, industrial chemicals, heavy metals, and petroleum products.

In general, many kinds of contamination can affect both farm-raised and wild-caught seafood. Different countries allow the use of different vaccines, feed additives, and antibiotics for farm-raised fish and fishery products and therefore, in some cases, residues from these production inputs may cause food safety concerns (FDA, 2001). On the other hand, wild-caught seafood may be more likely affected by other kinds of contamination such as from histamine (FDA, 2001). For the most part, seafood is more perishable than livestock or poultry. The potential for relatively faster decomposition gives seafood a shorter shelf life and makes handling more difficult.

## FDA Import Detention Data for Seafood

The Federal Food, Drug and Cosmetic Act (FFDCA) was enacted to protect the health and safety of Americans and to protect them from mislabeled or adulterated domestic or imported food products. In particular, Section 801 directs the FDA to detain any seafood imports that appear to violate the Act. FDA may take a "detention action" based on:

(1) Regular detentions, which include shipments where physical analysis or records show that the food appears to violate the FFDCA and other acts enforced by the FDA, or

(2) Detentions without physical examination (DWPE), which include:

(a) automatic detentions based on past violative history of individual processors, countries, or geographic areas, or

[4] Although *Vibrio vulnificus* causes fewer than 50 foodborne illnesses in the United States each year, it has the highest case fatality rate (39 percent) and second highest hospitalization rate (91 percent) of known foodborne pathogens (Mead et al., 1999). In a case study, Buzby and Frenzen (1999) analyze product liability lawsuits associated with *Vibrio vulnificus* in raw oysters.

(b) detentions based on import alerts, which may cover one or more firms or countries, and arise from new food safety concerns that are identified by U.S. officials and perceived to be a threat to human health.

DWPE have a substantial deterrent effect on the incentive to ship tainted or suspect seafood into the United States, and also illustrate food safety concerns of U.S. officials. DWPE are included in this analysis as they represent the large majority of detentions.

FDA provided us with monthly data on detentions in the form of electronic Import Detention Reports (IDR). Each IDR provides insight into the range and number of possible import violations. Here we analyzed FDA import detention data for "fishery/seafood products" with each record in the IDR representing one detained shipment. Each record generally includes data naming the country, product, product code, product description (e.g., frozen shrimp), manufacturer, city and state of the manufacturer, detention type, sample number, and reasons for detention. Some limitations or caveats of the IDR data for seafood products include:

- Only a small percentage of all seafood imported into the United States is physically inspected, meaning that the detention data likely does not capture all food safety problems. On average, during 1999-2001, less than 1 percent of shipments were detained for any of the above reasons, and even fewer were physically sampled for contamination.[5] However, the sampling strategies by FDA and other agencies are designed to focus enforcement and inspection efforts on areas that have the highest probability of having a problem (Ahmed, 1991).
- The sample of detentions includes many shipments that are found to pose no food safety problems and are released so that trade is resumed. That is, most detained shipments are released with re-examination, new documentation, or new labeling. Other detained shipments are re-exported elsewhere or destroyed. On average, during 1999-2001, 78 percent of detained shipments were released for import into the United States.[6] The large percentage of shipments that are released after being detained reflects the cautious approach that FDA takes in protecting human health.
- The FDA data provided to us did not include the dollar value of detained shipments.

FDA separates the reasons for seafood detentions into two main categories, misbranding and adulteration, and three smaller categories (table 1). Misbranding includes untruthful labeling or lack of labeling whereas adulteration deals with safety, packaging integrity, or sanitation problems (Caswell and Wang, 2001).

In 2001, FDA listed a total of 4,912 detentions for seafood products, which includes 6,405 violations (detentions can be for multiple violations). Of the violations, 83.6 percent were attributed to adulteration, 14.3 percent were for misbranding, and 2 percent for insanitary manufacturing, processing, or packing. Two types of adulteration accounted for slightly more than half of all violations. *Salmonella* was the most common violation (34 percent) for adulteration with seafood coded as "filthy" as the second most common violation (27 percent) (table 7.1).

Of the approximately 130 countries that export seafood products into the United States, 86 had one or more shipments detained in 2001 and 80 had violations for adulteration. Although *Salmonella* was the most common violation, other potential violations occurred in a greater number of countries. *Salmonella* violations occurred in 42 percent of the countries with detentions, whereas over 75 percent of countries had products detained for being "filthy" and 63 percent of countries had products detained for "no process," meaning that the manufacturer had not filed information on its scheduled process.

Because of this chapter's emphasis on food safety, the focus here is on violations for adulteration. The smaller category titled "insanitary manufacturing, processing, or packing" is listed separately in table 7.1, but is combined with adulteration for the remainder of this analysis as it also has implications for food safety.

Table 7.2 breaks down the FDA import detentions for adulteration by exporting country. The number of detentions by country is hard to interpret alone because of the variation in number and magnitude of shipments from a particular country. Therefore, we computed detention rates (i.e., the number of FDA detentions per $1 million imports to the United States)

[5] According to data provided by Mary Snyder of the FDA's Office of Seafood, 11,686 import shipments were detained at the port of entry by FDA out of 1,650,350 line entries during 1999-2001 (or <1 percent).

[6] Of the 11,686 detained shipments during 1999-2001, 9,120 were later released (some with reconditioning).

## Table 7.1—FDA violations for detaining fishery/seafood products, 2001

| Violation code | No. of violations | % of all violations | Violation description | No. of countries |
|---|---|---|---|---|
| **Total violations** | 6,405 | 100.0 | | 86 |
| **Adulteration** | 5,356 | 83.6 | | |
| *Salmonella* | 1,832 | 28.6 | The article appears to contain *Salmonella*, a poisonous and deleterious substance which may render it injurious to health. | 36 |
| Filthy | 1,460 | 22.8 | The article appears to consist in whole or in part of a filthy, putrid, or decomposed substance or be otherwise unfit for food. | 62 |
| No process | 683 | 10.7 | It appears that the manufacturer has not filed information on its scheduled process as required. | 54 |
| Insanitary | 351 | 5.5 | The article appears to have been prepared, packed or held under insanitary conditions whereby it may have been contaminated with filth, or whereby it may have been rendered injurious to health. | 25 |
| Needs acid/Needs fce | 336 | 5.2 | It appears the manufacturer is not registered as a low acid canned food or acidified food manufacturer. | 42 |
| Poisonous | 231 | 3.6 | The article appears to contain a poisonous or deleterious substance which may render it injurious to health. | 38 |
| *Listeria* | 170 | 2.7 | The article appears to contain *Listeria*, a poisonous and deleterious substance which may render it injurious to health. | 11 |
| Histamine | 123 | 1.9 | The article appears to contain Histamine, a poisonous and deleterious substance which may render it injurious to health. | 11 |
| Imptrhaccp | 41 | 0.6 | The food appears to have been prepared, packed or held under insanitary conditions, or may have become injurious to health, due to the failure of the importer to provide verification of compliance. | 5 |
| Unsafe col | 41 | 0.6 | The article appears to be, or to bear, or contain a color additive which is unsafe. | 14 |
| All other violations[1] | 88 | 1.4 | Violations includes those for food that—appears to have been prepared or packed under insanitary conditions, contains excessive sulfites, contains or been packed in containers that have poisonous substances, contains unsafe food additives, contains unsafe pesticides, has had inadequate processing, consists of a filthy, putrid or decomposed substance, contains an off odor, or has been held in swollen or leaking containers. | 46 |
| **Insanitary manufacturing, processing, or packing** | | | | |
| Mfr insan | 130 | 2.0 | The article appears to have been manufactured, processed, or packed, under insanitary conditions. | 27 |
| **Misbranding** | 914 | 14.3 | | |
| Nutrit lbl | 200 | 3.1 | The article appears to be misbranded in that the label fails to bear the required nutrition information. | 33 |
| Lacks firm | 140 | 2.2 | The food is in package form and appears to not bear a label containing the name and place of business of the manufacturer, packer, or distributor. | 32 |
| Usual name | 136 | 2.1 | It appears that the label does not bear the common or usual name of the food. | 28 |
| List ingre | 87 | 1.4 | It appears the food is fabricated from two or more ingredients and the label does not list the common or usual name of each ingredient. | 29 |
| Lacks n/c | 84 | 1.3 | The food is in package form and appears to not have a label containing an accurate statement of the quantity of the contents in terms of weight, measure, or numerical count and no variations or exemptions have been prescribed. | 25 |
| False | 70 | 1.1 | The labeling for this article appears to be false or misleading | 13 |
| No English | 47 | 0.7 | Required label or labeling appears not to be in English. | 21 |
| Labeling | 46 | 0.7 | The article appears in violation of FPLA because of its placement, form, and/or contentsstatement. | 21 |
| Sulfitelbl | 40 | 0.6 | The labeling appears false and misleading because it appears to contain sulfites, but thelabel fails to declare the presence of sulfites, a fact material to sulfite-sensitive individuals who must avoid the ingredient. | 4 |
| All other violations[1] | 64 | 1.0 | Violations include those for food that—appears to be offered for sale under the name of another food, appears to contain an unlabeled chemical preservative, required labeling is not visible enough, purports to be for special dietary uses and its label does not bear required nutritional information, appears to contain additives which are not declared on the label, or appears to be represented as a food for which a standard of identity has been prescribed and does not appear to conform to that definition. | 35 |

Note: Two smaller FDA categories not show here. Complete list of violations are available upon request.

[1]Each individual violation in these groups represent less than 0.5 percent of all violations.

Source: Computed by the authors using FDA Import Detention Reports, January-December, 2001.

using census data on the value of imports obtained from the National Marine Fisheries Service website.[7]

The top three countries in terms of the number of violations in 2001 were Vietnam, Thailand, and Indonesia—all among the top eight exporters of seafood products to the United States. Vietnam had 580 detentions worth $478 million in exports, resulting in a rate of 1.21 detentions per $1 million of exports. This detention rate is almost triple the average for all countries (0.46). Although Thailand had the second highest number of detentions (407), it also had the second highest value of exports and a detention rate below average (0.25). Canada, the number one importer in terms of value, had the lowest detention rate (0.03). Again, two caveats are that only a small percentage of products are inspected, and enforcement/inspection efforts are focused on areas with the highest probability of having a problem.

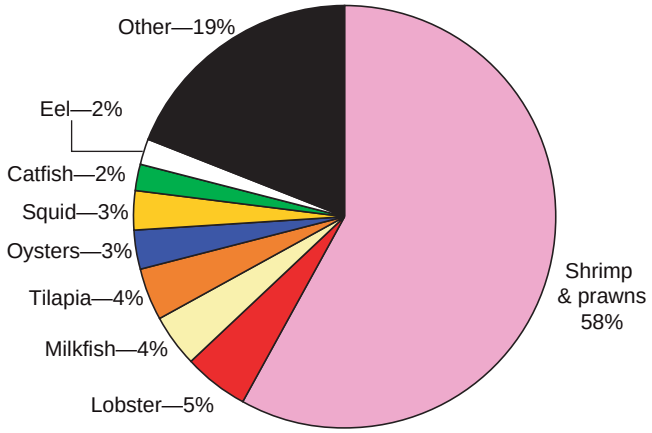
An earlier study by Sun (2002) computed the detention ratios for fishery products by country over 1997-2000 and found that most ratios remained low. However, the ratios for some countries, including Vietnam, fluctuated wildly.

Table 7.3 breaks down the FDA seafood product detentions for adulteration by class and product. Fish was the most implicated class, with 45.3 percent of all detentions. This is not surprising since this category contains more than 60 types of fish and includes high-volume products such as tuna and salmon. However, when looking at individual products, by far, the most implicated product was shrimp and prawns (marine plus aquaculture combined), accounting for more than one-quarter of all detentions. This finding was expected because shrimp was by far the largest single import item, with 40 percent of the value of seafood imports in 2001.

Table 7.4 looks more closely at the number of violations in the 2001 FDA detention data to determine the types of seafood products detained for different reasons. Shrimp and prawns ranked the highest in terms of the number of violations for 6 of the top 11 violation codes for adulteration. In particular, shrimp and prawns accounted for 58 percent of the *Salmonella* violations (fig. 7.4) and 48 percent of the violations for filth.

[7] *www.st.nmfs.gov/st1/trade/trade_prdct_cntry-com.html*, accessed April 2002.

Figure 7.4
**U.S. FDA violations for *Salmonella*, by seafood product, 2001**




Source: ERS calculations using 2001 FDA Import Detention Reports.

In summary, out of 130 countries represented in FDA import detention data, 86 had one or more violations in 2001 for one or more reasons and 80 of these had violations for adulteration. Detention rates in terms of value were low, with an average of 0.46 detentions per $1 million of imports. Of the 6,405 violations, 83.6 percent were for adulteration, with *Salmonella* accounting for 28.6 percent of the adulteration violations. More than one-quarter of the detentions were for shrimp and prawns (marine plus aquaculture) which was expected because shrimp is by far the largest seafood import item.

## Seafood Safety Incidents Affecting International Trade

In general, it appears that seafood safety issues have been less publicized in the media than the food safety issues linked to some of the other agricultural products covered in this report. Nevertheless, international disputes over seafood safety have affected trade opportunities for producers, exporters, and importers.

In 1994, the Spanish government rejected two shipments of squid from the United States. The squid was found to contain copper in excess of 20 parts per million (ppm), which Spain had established as the maximum allowable amount of copper.[8] The 20-ppm level was advantageous to Spanish squid producers because Spanish squid naturally has lower levels of copper than

[8] Copper is an essential trace mineral nutrient.

**Table 7.2—FDA import detentions for adulteration of fishery/seafood products versus value of imports, 2001**

| Country[1] | Detentions | | U.S. fishery/ seafood imports | | Number of detentions per $1 million imports |
|---|---|---|---|---|---|
| | *Number* | *% of total* | *Mil. dol.* | *% of total* | *Number* |
| Total[2] | 4,431 | 83.1 | 9,533.6 | 93.4 | 0.46 |
| **Vietnam** | **580** | **13.1** | **477.9** | **5.0** | **1.21** |
| **Thailand** | **407** | **9.2** | **1,607.7** | **16.9** | **0.25** |
| **Indonesia** | **366** | **8.3** | **382.1** | **4.0** | **0.96** |
| Ecuador | 321 | 7.2 | 392.8 | 4.1 | 0.82 |
| India | 312 | 7.0 | 296.1 | 3.1 | 1.05 |
| Taiwan, Republic of China | 270 | 6.1 | 185.7 | 1.9 | 1.45 |
| Philippines | 246 | 5.6 | 148.1 | 1.6 | 1.66 |
| Korea, Republic of (South) | 206 | 4.6 | 74.1 | 0.8 | 2.78 |
| China (Mainland) | 150 | 3.4 | 659.1 | 6.9 | 0.23 |
| Mexico | 122 | 2.8 | 487.0 | 5.1 | 0.25 |
| Japan | 114 | 2.6 | 120.2 | 1.3 | 0.95 |
| Chile | 85 | 1.9 | 483.4 | 5.1 | 0.18 |
| Bangladesh | 68 | 1.5 | 94.1 | 1.0 | 0.72 |
| Brazil | 68 | 1.5 | 155.4 | 1.6 | 0.44 |
| **Canada** | **64** | **1.4** | **1,945.4** | **20.4** | **0.03** |
| Norway | 52 | 1.2 | 115.1 | 1.2 | 0.45 |
| Nicaragua | 40 | 0.9 | 81.6 | 0.9 | 0.49 |
| Costa Rica | 32 | 0.7 | 78.4 | 0.8 | 0.41 |
| Honduras | 30 | 0.7 | 123.1 | 1.3 | 0.24 |
| Australia | 24 | 0.5 | 70.1 | 0.7 | 0.34 |
| Panama | 24 | 0.5 | 104.0 | 1.1 | 0.23 |
| Venezuela | 21 | 0.5 | 118.7 | 1.2 | 0.18 |
| Iceland | 20 | 0.5 | 151.7 | 1.6 | 0.13 |
| Argentina | 19 | 0.4 | 105.1 | 1.1 | 0.18 |
| Russia | 19 | 0.4 | 215.4 | 2.3 | 0.09 |
| Guyana | 10 | 0.2 | 58.4 | 0.6 | 0.17 |
| New Zealand | 9 | 0.2 | 112.2 | 1.2 | 0.08 |
| Fiji | 5 | 0.1 | 57.3 | 0.6 | 0.09 |

[1] Includes only countries with at least 0.5 percent of total imports. Complete list of countries available upon request.
[2] Excludes import detentions from U.S. territories included in tables 7.1, 7.3, and 7.4.

Source: Computed by the authors using FDA Import Detention Reports, January-December, 2001 and National Marine Fisheries Service, Foreign Trade Information website: *http://www.st.nmfs.gov/st1/trade/trade_prdct_cntry.html*, accessed April 2002.

squid from other countries. After a few months the dispute was resolved and the U.S. went on to export a record $16 million of squid to Spain in 1994 (USDA Foreign Agriculture Service, 1995).

In 1997, the European Commission (EC) banned shrimp imports from Bangladesh because processing plants in Bangladesh did not meet EC standards. The estimated net cost of this August-December 1997 ban after considering shipments diverted to other countries was $14.7 million to the Bangladesh frozen shrimp processing industry (Cato and Lima dos Santos, 1998). As in many other less developed countries (LDCs), many plants in Bangladesh have difficulty meeting the required quality and safety standards because of a lack of sufficient funds to invest in quality control measures, more adequately trained staff, and expensive equipment (Rahman, 2001). The Bangladesh Department of Fisheries, Fish Inspection, and Quality Control has verified and certified compliance of seafood products for only 20 percent of the seafood processing companies that previously were shipping to the European Union (EU) (Cato, 1998). This ban affirms the apprehension of some LDCs that evolving standards under the WTO will become a major market access issue (Rahman, 2001).

Since 1997, Kenya and some other countries surrounding Lake Victoria have faced a series of food safety-related restrictions of their fish exports (Henson et al.,

**Table 7.3—FDA import detentions for adulteration of fishery/seafood products, by class and product, 2001**

| Class and product | Number of detentions | Percent of total detentions | Number of countries |
|---|---|---|---|
| **Total** | **4,451** | **100.0** | **80** |
| **Fish** | **2,016** | **45.3** | **73** |
| Tuna (Albacore, Yellowfin, Skipjack, etc.) | 367 | 8.2 | 27 |
| Swordfish | 224 | 5.0 | 37 |
| Sardines (Brisling, Sprats, Pilchards, etc.) | 171 | 3.8 | 32 |
| Mahi Mahi | 122 | 2.7 | 11 |
| Mackerel | 104 | 2.3 | 26 |
| Salmon (Humpback, Silver, King Sockeye, etc.) | 95 | 2.1 | 17 |
| Milkfish | 94 | 2.1 | 3 |
| Other[1] | 839 | 18.8 | 55 |
| **Crustaceans** | **1,308** | **29.4** | **41** |
| Shrimp and prawns | 1,043 | 23.4 | 35 |
| Crab | 126 | 2.8 | 14 |
| Lobster | 120 | 2.7 | 10 |
| Other[2] | 19 | 0.4 | 7 |
| **Aquaculture harvested fishery/seafood products** | **413** | **9.3** | **20** |
| Shrimp and prawns | 365 | 8.2 | 13 |
| Other[3] | 48 | 1.1 | 11 |
| **Shellfish[4]** | **224** | **5.0** | **31** |
| **Other fishery products[5]** | **222** | **5.0** | **36** |
| **Other aquatic species[6]** | **226** | **5.1** | **18** |
| **Mixed fishery/seafood products[7]** | **37** | **0.8** | **13** |
| **Engineered seafood[8]** | **5** | **0.1** | **2** |

[1] Includes anchovy, barracuda, bass, blue fish, bonito, bream, carp, catfish, cod, corvina, croaker, cusk, dace, eel, escolar, filefish, flounder, gourmay/gourami, groupers, hake, halibut, herring, jack, kingfish, marlin, mud fish, mullet, perch, pike, pickerel, pollack/pollock, pompano, puffer, rockfish, suary, scad, shark, sheatfish, smelt, snake head, snapper, sole, spot fish, tilapia, totoava, trout, turbot, wahoo, white fish, whiting, yellowtail, and other products not classified. [2] Includes crayfish, langostino, and other products not classified. [3] Includes catfish, clams, frogs, mussels, oysters, salmon, tilapia, and other products not classified. [4] Includes abalone, arkshells, clams, cockles, conch, conchmeat, mussels, oysters, scallops, and other products not classified. [5] Includes caviar/roe, fish maw, fish paste, fish sauce, gefilte fish, shark fin, and other products not classified. [6] Includes cuttlefish, frog legs, octopus, sea cucumber, sea urchin, snails, squid, and other products not classified. [7] Includes chowders, stews, bisques, hors d'oeuvres, salads, stuffed pastas, tuna sandwiches, and other products not classified.[8] Includes crab and surimi used for imitation crab and other products not classified.

Source: Computed by the authors using FDA Import Detention Reports, January-December 2001.

2000). *Salmonella* contamination in Nile perch from Kenya in April 1997 led to border testing of all Nile perch consignments. Later, a cholera epidemic in East Africa in December 1997 resulted in a European Commission ban of imports of fresh fish products from Kenya, Mozambique, Tanzania, and Uganda until June 1998. The World Health Organization and Food and Agriculture Organization issued statements that the ban was not scientifically justifiable and the restrictions were lifted in June 1998. For Mozambique alone, the ban resulted in a loss of $60,000 in trade per month while the ban was in place, which means that about 30 tons of fish were not traded to the European Union market (Cato, 1998). Following reports of pesticide poisoning of fish from Lake Victoria, another round of restrictions began in April 1999 that prohibited all fish exports from Lake Victoria to the EU (Henson et al., 2000). As a result of these events, employment in the sector declined and industrial fish processing companies reduced capacity or closed (Henson et al., 2000).

In January 2002, the EU suspended shrimp and prawn imports (and other products of animal origin) from China because of residues from a banned antibiotic, chloramphenicol, and because of general deficiencies in the Chinese residue control system (McGovern, 2002). This antibiotic is used in some animal and seafood feed to control disease. It has been linked to fatal leukemia and anemia in humans. The FDA response was to step up surveillance for chloramphenicol residues and residues of other unapproved aquaculture drugs in shrimp and crayfish imports from all countries and to modify its testing methods so as to be able to detect the antibiotic at 0.3 part per billion, equal to that of Canada and the EU. Products with

**Table 7.4—FDA violations for adulteration of fishery/seafood products by reason for contravention and main products detained, 2001**

| Violation code | No. of violations | Main products detained |
|---|---|---|
| **Total violations** | 5,486 | |
| **Adulteration** | | |
| *Salmonella* | 1,832 | Shrimp/prawns, 58%; lobster, 5%; milkfish and tilapia, each 4%; oysters and squid, each 3%. |
| Filthy | 1,460 | Shrimp/prawns, 48%; tuna, 11%; mahi mahi, 7%; crab 4%, conch/conchmeat, 3% . |
| No process | 683 | Sardines, 20%; tuna, 17%; mackerel, 7%; herring, 5%; salmon and shrimp/prawns, each 4%; anchovy, clams, and octopus, each 3%. |
| Insanitary | 351 | Shrimp and prawns, 69%; crab, 4%. |
| Needs acid/Needs fce | 336 | Tuna, 18%; sardines, 17%; herring, 8%; mackerel, 7%; crab, 6%; anchovy and shrimp/prawns, each 5%; snails, 4%. |
| Poisonous | 231 | Swordfish, 87%. |
| *Listeria* | 170 | Salmon, 17%; fish roe/caviar, 14%; crab and shrimp/prawns, each 11%; pollack, 10%. |
| Histamine | 123 | Mahi mahi, 53%; tuna, 32. |
| Imptrhaccp | 41 | Milkfish, 39%; tuna and groupers, each 17%. |
| Unsafe col | 41 | Shrimp/prawns, 29%; seafood salad, 17; fish roe, 12%. |
| Mfrhaccp | 32 | Shrimp/prawns, 41%; tuna, 34%. |
| Other | 56 | Shrimp/prawns, 34%; swordfish, 9%; anchovy and milkfish, each 5%. |
| **Insanitary manufacturing, processing, or packing** | | |
| Mfr insan | 130 | Anchovy and clams, each 12%; oysters, 12%; mackerel, 7%; mussels and pollack, each 6%. |

Note: See table 7.1 for definitions of violation codes.

Source: Computed by the authors using FDA Import Detention Reports, January-December, 2001.

detectable levels of chloramphenicol will be detained and refused entry into the United States (FDA Press Release, 2002.). Also, the U.S. temporarily suspended shrimp imports from China.

Although some of these seafood safety incidents appear to have resulted in relatively limited and short-term interruptions of trade and economic impacts, costs could continue to accrue from continued market diversions (i.e., lost market share), loss of momentum in the sector, decreased prices, and reduced capacity due to temporary or permanent plant closures. The above examples illustrate that food safety restrictions can act as barriers to trade as they can for any type of food. Despite the advantages of some developing countries in terms of preferential trading arrangements, food safety incidents can impose costly requirements on developing countries beyond their ability to afford compliance (Henson et al., 2000).

## Public and Private Actions To Ensure Safer Seafood

Federal regulation of seafood imports has tended to focus on end product testing and inspection, except for where memoranda of understanding (MOU) are in place (Ahmed, 1991, p. 15).[9] More recently, HACCP systems have been increasingly implemented by private industry for seafood, sometimes voluntarily and sometimes as mandated by governments. HACCP plans generally follow seven steps: conduct a hazard analysis; identify critical control points (CCP) for physical, biological, and chemical hazards; establish critical limits for preventative measures associated with each CCP; establish CCP monitoring requirements; determine and perform corrective actions; establish recordkeeping systems; and conduct verification procedures. This system has become one of the more common public actions used to ensure safer seafood, particularly in developed countries.

Canada was the first country to establish a mandatory food inspection program for fish and fishery products based on HACCP principles. In 1992, Canada adopted the Quality Management Program (QMP) whereby all federally registered fish processing establishments in Canada must implement a system of procedures,

[9] FDA has had other programs in place for a long time to address food safety issues, such as the low acid canned food regulations to reduce the risk of botulism.

inspections, and records. Meanwhile, importers who wish to be in product compliance with federal regulations may develop a quality management system and provide details through a Quality Management Program for Importers (QMPI) submission to the Canadian Food Inspection Agency (CFIA, 2002).

In 1991 and 1994, the European Commission adopted regulations concerning health conditions for production and marketing of fishery products, and again these were roughly based on HACCP principles (FAO, 2000). In 1995, the FDA promulgated a HACCP program for fish and fishery products stipulating that importers of seafood to the United States must meet the same HACCP standards as U.S seafood processors (*Federal Register*, Dec. 18, 1995). Since then, other developing and developed countries have made similar initiatives. The level of U.S. seafood exports has been sustained despite the U.S. HACCP regulation for fish and fishery products. This means that increased seafood regulation need not have a significant detrimental effect on international seafood trade at the current levels of production. Although higher safety standards raise seafood production costs, the increasing worldwide demand for high-quality seafood has offset these cost increases (Sun and Caswell, 2002).[10]

Inspection protocols and regulatory limits for contaminants vary tremendously across countries (Ahmed, 1991, p. 15), and HACCP systems vary as well. For example, the EU regulations apply to the whole production chain whereas the U.S. seafood HACCP regulations apply only to processors (FAO, 2000). WHO/FAO Codex Alimentarius incorporated HACCP in its general guidelines in 1997, thus creating a starting reference for trade disputes under the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (FAO, 2000).

Meanwhile, private industry may invest in new technologies and equipment that ensure safer food and may take certain measures to reduce food safety risk (which may or may not be part of HACCP systems) such as rapid cooling, irradiation, proper processing, and good temperature control at all stages of the production and distribution chain. Additionally, some companies voluntarily test for *Vibrio,* histamine, or other contaminants. The leading trade association for fish and seafood products in the United States is the National Fisheries Institute, founded in 1945. One component of their mission is food safety education for the seafood industry, which includes scientific and technical information on key issues such as HACCP, irradiation, mandatory recalls, mercury, and voluntary seafood inspection services.

Identity preservation is another means of ensuring safety, one that is attracting attention in the international trade arena. Under an identity preservation system, information about the origin of a "lot" of food follows that lot from harvest all the way to the consumer. An identity preservation system has been in place since 1925 for molluscan shellfish harvested in the United States. This system is under the auspices of the National Shellfish Sanitation Program (NSSP). The NSSP is a Federal, State, and industry voluntary cooperative program that relies on regulatory controls by State shellfish authorities to ensure safe molluscan shellfish. Among other requirements, the NSSP requires that containers of raw shellfish have identity tags that stay with the shellfish from harvest to sale to the consumer. The tags must include the identity of the shellfish harvester/dealer and the date and location of harvest. Lot identity of the shellfish must be maintained throughout the production and marketing chain. The identity preservation system has been very helpful to authorities in the control of foodborne illness. But it is not a complete solution to the seafood safety problem. Tags may be lost or switched and the existence of tags does not control pathogens and other hazards. Other regulations include certification of domestic and international growing waters for bivalves to be consumed in the United States. Many foodborne illnesses each year are still associated with consumers eating raw molluscan shellfish in the United States.

Regulations for other forms of labeling (e.g., country-of-origin labeling) may be motivated more by concerns other than food safety. For example, as of January 2002, an EC regulation requires seafood and fish products to be labeled with information on the harvest area, harvest water type, commercial species name, and whether the product was cultivated or wild. This regulation will help government officials police

[10] More significant are the differential effects that safety standards have across countries that supply seafood to the U.S. market. Sun and Caswell (2002) indicate both positive and negative effects on volume exported to the U.S. in excess of 30 percent for different seafood exporting nations. Both developed and developing countries experienced sizable negative effects. While large positive effects were mainly experienced by developed nations, smaller positive effects were experienced by some developing nations (Sun and Caswell, 2002).

the Common Fisheries Policy and to help inform consumers (WorldCatch, 2001).[11]

Currently, U.S. Customs requires importers to provide documents that include the country of origin for seafood products. Some specific seafood products additionally are labeled as either farm-raised or wild harvest.[12] In the Farm Security and Rural Investment Act of 2002, Section 10816 contains two new labeling requirements pertaining to seafood. The first requirement is that seafood must have country-of-origin labels.[13] The second requirement is that the labeling has to distinguish between farm-raised and wild harvest seafood products.

## Implications for Policymakers

This chapter has three main conclusions, some of which have implications for policymakers.

*Point 1: Salmonella is a potential target for risk reduction efforts.*

The FDA detention data showed that *Salmonella* was the most common contaminant resulting in adulteration of fish and fishery products. Interestingly, the meat and poultry chapters of this report also found that *Salmonella* was a key food safety concern for those products and the U.S. Centers for Disease Control and Prevention outbreak data show that *Salmonella* was the most common cause for bacterial foodborne disease outbreaks in produce during 1993-97.[14] Therefore, *Salmonella* might be a food safety problem to target for increased risk-reduction efforts in food production, particularly given that *Salmonella* is a leading cause of foodborne illness in the United States and worldwide.

*Point 2: Most Salmonella contamination detentions are for shrimp.*

As most *Salmonella* contamination in fish and fishery products are with shrimp, risk reduction efforts could be focused here. And, as over one-quarter of shrimp production is from aquaculture, improvements in sanitation and production practices could perhaps make substantial differences in the occurrence and extent of *Salmonella* contamination. But this won't solve all the problems because unlike meat and poultry, where *Salmonella* may be a naturally occurring bacteria in the animals' digestive tracts, for seafood, *Salmonella* contamination is often due to cross-contamination introduced later during the processing stage.

However, for the foreseeable future, shrimp will continue to be produced primarily by developing nations and dominate seafood trade from developing nations to developed nations (Wessells, 2002). Many less developed countries may have difficulty meeting the required quality and safety standards because of a lack of insufficient funds to invest in quality control measures, more adequately trained staff, and expensive equipment (Rahman, 2001).

*Point 3: International seafood markets will continue to expand and become increasingly segmented.*

The FAO report *The State of the World Fisheries and Aquaculture* (2000) predicts that international trade of fish and fishery products will grow in two ways. First, fish processing in developing countries will increase due to its attractiveness as an employment-generating opportunity for low-wage workers, particularly in displaced fishing communities, and due to the increased demand for value-added fishery products. Second, developing countries increasingly will become important markets for these products. Fish is becoming a greater source of animal protein around the world—average annual per capita fish consumption has increased from 9 kilograms in the early 1960s to 16 kilograms in 1997 (FAO, 200).

The FAO report (2000) also predicts that by 2030, more than 50 percent of fish supplies will be from aquaculture and that imports will account for an increasing share of consumption in wealthy countries. In the United States, the average import share of fish and shellfish consumption increased from 56.3 percent in 1990 to 68.3 percent in 2000. In general, an increasing share of imports means that wealthy countries will likely want to remove most trade barriers so that these

[11] The Common Fisheries Policy is the system of quotas and tariffs that the EU uses to manage fisheries and aquaculture issues from harvest to consumption.

[12] The term "wild harvest" fish means naturally born or hatchery-raised fish or shellfish that are harvested in the wild. The term "wild fish" excludes net-pen aquaculture, primarily salmon, or other farm-raised fish.

[13] To be labeled as a product of the U.S., farm-raised fish have to be hatched, raised, and processed in the U.S. For wild fish to be labeled as a product of the U.S., it must be harvested in U.S. waters or a U.S. territory and it must also be processed in the U.S. or a territory of the U.S.

[14] The caveats about outbreak data apply here as well: the data do not capture unreported outbreaks or sporadic cases of foodborne illness.

products will become less expensive (FAO, 2000). However, wealthy countries also tend to want higher levels of food safety and tend to be willing to pay more for food safety. In the future, we may see greater evidence of market segmentation where wealthy countries such as the United States, Japan, and EU members demand higher valued seafood products with food safety ensured, while less wealthy countries consume lower value species (e.g., carp) with fewer safety assurances (Wessells, 2002). This means that the degree of food safety could become, to some extent, a source of product differentiation.

Governance over marine resources is complex because of intersecting goals arising out of concerns for food safety, marine resource management, worker safety, and market access.[15] In particular, food safety disputes often require a delicate balancing between the costs of mitigating human health risks and benefits of open trade. Trade for seafood is particularly complex because of the large number of species traded, countries involved, and production processes used.

HACCP as an international trade standard for ensuring safe seafood will continue to evolve and be adopted by more governments. And, if countries develop similar HACCP requirements for seafood, this will facilitate trade. Currently, the United States does not have equivalence agreements with other countries for HACCP for seafood products, partly because they are difficult to achieve. Therefore, we have limited reach or control over the actual practices used by seafood importers into the United States, and there will continue to be special challenges that arise from seafood trade between developed and developing countries.

[15] The most dangerous occupation in the world is fishing at sea (FAO, 2000).

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*Chapter 8*

# The Belgian Dioxin Crisis and Its Effects on Agricultural Production and Exports

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## Summary

The Belgian dioxin crisis began in January 1999 when animal feed in Belgium was contaminated with cancer-causing dioxin and polychlorinated biphenyls (PCBs). Dioxin-contaminated feed was then fed to chicken, swine, and other food animals, subsequently affecting a large array of agricultural industries and temporarily interrupting trade with the United States and more than 30 other countries.[2] This chapter provides some analysis of agricultural exports and production effects of the crisis. It complements previous chapters by providing an example of a food safety crisis that resulted from an isolated event involving a persistent organic pollutant and that affected a wider range of food sectors than most other food safety issues.

Belgium-Luxembourg exports were adversely affected by the crisis in the short run. Export growth rates for the decade prior to the crisis were positive for five key agricultural categories (eggs, dairy products, swine products, poultry products, and "other" meat products). However, the percentage change in the growth rate between 1998 and 1999, representing the shortrun effects of the crisis, dropped and became negative for eggs, swine products, and dairy products, with the largest decline for "other meat" products (-32.1 percent). Although the growth rate for poultry products also fell dramatically, it remained positive at 2.3 percent during 1998-99.

The dioxin contamination originated in animal feeds, yet other production sectors were far more affected in percentage terms. This study use Belgium-Luxembourg monthly production data from the Belgian Ministry of Economic Affairs, National Institute of Statistics (NIS) (1999). Poultry meat products, meat and meat products, and slaughtering of cattle were especially hit hard by the crisis, Other product categories such as fish and fish products, actually benefited as buyers switched to products not implicated in the contamination. Feed production even increased slightly in July 1999 due to a temporary slaughter ban that initially kept many animals on the farms.

Dioxin and/or PCB contamination in feed has occurred in several countries since the Belgian dioxin crises, though to a lesser extent. This crisis was a large-scale, isolated event and did not represent an ongoing or evolving food safety problem. One challenge illustrated by the 1999 crisis is the fine balance between gathering sufficient information on such an event (e.g., source, cause, human and animal health risks) and the timely and accurate release of information to the public and to trading partners. Overcoming this challenge will be important for governments and implicated industries in order to minimize damage to food markets and maintain consumer confidence in both the food supply and in governments' ability to handle food safety crises.

[1] Authors are economists with the Food and Rural Economics Division of the Economic Research Service.

[2] The terms "swine" and "swine products" are used hereinafter instead of "hogs" or "pork products" in order to be consistent with the category names used in the Belgian data.

## Introduction

The Belgian dioxin crisis exemplifies a food safety crisis that: (1) arose from a large-scale, isolated contamination event as opposed to an ongoing or evolving problem, (2) involved a persistent organic pollutant as opposed to other food safety hazards, such as pathogens, (3) adversely affected multiple agricultural sectors and countries importing from these sectors, and (4) may have been the result of some form of deliberate contamination. Shortly after the Belgian government announced the crisis in late May 1999, the media alleged that the contamination was the result of the deliberate or accidental use of motor oil or some other industrial oil in an animal fat mixture (Lok and Powell, 2000). However, the Belgian government has not provided an official confirmation of the source of the contamination or how it occurred (Lok and Powell, 2000). A more recent and scientific article attributes the crisis to a fat mixture made with mineral oil containing PCBs—"most likely oil from discarded transformers originating from a waste recycling center" (van Larebeke et al., 2001). Because the public announcement of the crisis occurred at one point in time, it is possible to compare Belgian food production and trade before and after the crisis. However, this chapter is not meant to be a report of a comprehensive economic analysis.

## Background on Dioxin

Dioxin is a general term for hundreds of chemicals that are highly persistent in the environment. Dioxins are created as a byproduct of chemical processes. Some are created from natural causes such as forest fires and volcanic eruptions; dioxins can be found throughout the natural world (in soil, water, and air, for example). Accidental and uncontrolled fires at landfills also add to dioxin levels. Exhaust emissions and processes such as pulp and paper bleaching, incineration, and the manufacturing of steel, chemicals, and paint also release dioxins and contaminate the environment (EC, July 20, 2001). Absorbed dioxins accumulate in body tissue and pose cancer and other human health risks—in general, the higher up the food chain, the greater the accumulation (WHO, 1999). Any dioxins released into the environment can accumulate over time in human and animal fatty tissue (EC, July 20, 2001). Contamination with polychlorinated biphenyls (PCBs) is often accompanied by dioxin contamination so both are often evaluated together.[3] The U.S. Food and Drug Administration (FDA) website provides extensive information on dioxins.[4]

Studies suggest that 80 percent (EC, July 20, 2001) to 95 percent (preliminary EPA estimate, 1994) of human exposure to dioxin is through the food supply, primarily through the dietary intake of animal fats from meat, poultry, and dairy products. At least in the United States, human exposure has also occurred historically from industrial accidents and from working in industries that produce dioxin as a byproduct, or through drinking contaminated breast milk. Dioxin in feed is thought to be the main contributing factor to the dioxin level in food from animals and animal products, though animals can also be exposed through contaminated soil, air, and water (EC, July 20, 2001). There is no international agreement on target levels for several reasons, including analytical method difficulties, lack of data (e.g., typical levels), and the lack of a clear distinction as to what level of dioxin is considered as "safe." However, the World Health Organization has elaborated a "tolerable daily dose."

Consumers have only a limited ability to restrict their exposure to foodborne dioxins (e.g., consuming low-fat dairy products and trimming fat from meat) and therefore national governments have essential roles in monitoring food safety and acting to protect public health (WHO, 1999). In general, dioxin contamination comes from either "background" contamination from the sources previously described or from specific, isolated incidents, which are rare. In July 1997, U.S. agencies found elevated levels of dioxin in some chicken, eggs, farm-raised catfish, and animal feed (FDA, March 13, 2003). A lengthy investigation traced the source of this incident to feed produced with "ball clay" from one Mississippi mine. The clay was used as an anticaking agent in soybean meal and has since been prohibited by FDA from use in any animal feed.

[3] PCBs are fluids that used to be used as transformers and insulators in some industrial settings in the United States. PCBs are more readily measurable, though dioxins drive health concerns. For simplicity, the term "dioxin" is sometimes used to cover both dioxin-like PCBs and dioxins.

[4] The Interagency Working Group on Dioxin (IWG) has developed very detailed information about dioxins on their website and this covers four topics: (1) general information about dioxins, (2) overview of the draft EPA dioxin report, (3) food safety questions and answers, and (4) risk assessment questions and answers. *www.cfsan.fda.gov/~lrd/dioxinqa.html*

Governments move quickly to stop dioxin contamination at the source if the source can be identified and removed. Countries have different ways of dealing with contamination, though both the United States and European Union have stringent laws for industrial sources that are driven by what technology can control (Winters, 2002). The European Commission (EC), the EU's governing body, recommends an overall strategy to reduce exposure to dioxins, including actions that reduce dioxin levels in the environment, animal feed, and food, with emphasis given to the sources of major importance (typically fish oil and fish meal) (EC, July 20, 2001). Although, in principle, a similar broad-based strategy is followed in the United States, the EU has set regulatory limits for dioxin in food whereas the U.S. doesn't have such limits because of concerns about lack of scientific basis. Some countries seek dioxin testing certification which is very expensive and only available from private sources (FAS, 2003).

Efforts to reduce dioxins over the past two decades have resulted in a downward trend in dioxin exposure for Europeans (EC, July 20, 2001). Similarly, dioxin levels in the U.S. environment have declined since the 1970s. The U.S. Environmental Protection Agency (EPA), State governments, and industry are working together to reduce the production of manmade dioxins (FDA, July/Aug. 2000).

## The Belgian Dioxin Crisis

The Belgian dioxin crisis began in January 1999, quickly spread across national borders, and had serious trade impacts. The crisis occurred when 60-80 tons of fat used in animal feed in Belgium was contaminated with almost 1 gram of cancer-causing dioxin and 40-50 kilograms of PCBs (van Larebeke et al., 2001). The contamination occurred when a fat smelting company added dioxin-contaminated oil to a mixture of fats for later use as a feed ingredient. This contaminated fat was then purchased by at least 10 feed mills and was used to make approximately 500 tons of contaminated animal feed—versus over 28,000 tons/week average production and use of feed in Belgium (van Larebeke et al., 2001). The contaminated feed was distributed mostly to poultry farms but also to rabbit, calf, pig, and cow breeding and raising farms in Belgium, with some distributed to Germany, France, and the Netherlands (van Larebeke et al., 2001). In Belgium alone, 746 pig farms, 445 poultry farms, 393 bovine farms, and 237 dairy farms used feed from the 10 producers of contaminated feed (van Larebeke et al., 2001). The following chronology of the crisis is abbreviated from a description in Lok and Powell (2000), which was based primarily on a 1999 Belgian government website:

- January 18-19, 1999—Fat mixture was contaminated with dioxin at Verkest, a fat and oil processing plant.
- End of January 1999—Contaminated fat was supplied to feed manufacturers and used to make feed, which was sold to broiler chicken, egg, pork, and beef producers.
- During February 1999—An animal feed manufacturer, the Da Brabender firm, noticed problems with hens used to produce 1-day old chicks.[5]
- March 3, 1999—Da Brabender notified their insurance company and this led to an investigation by Dr. Destickere, a veterinarian [and head of the West Flanders Inspectorate].
- Next 2 weeks in March 1999—Dr. Destickere concluded that the most likely source of the problem was the fat in animal feed.
- March 18, 1999—Da Brabender sent a sample of suspect animal feed produced in January 1999 for analysis.
- March 19, 1999—Da Brabender notified the Belgian Ministry of Agriculture.
- A few days later—The Belgian government began investigating and testing.
- April 21, 1999—Dr. Destickere reported his suspicions about dioxin as the source to the Belgian Ministry of Agriculture.
- April 26, 1999—Test results found high dioxin concentrations in feed and chicken fat samples.
- May 26, 1999—Test results found high dioxin levels in breeding eggs for hatching and in mother hens on farms that purchased from suspect feed manufacturers. This meant that there were high levels of dioxin in eggs and chicken on the market in April.

[5] The media reported that the first signs of contamination detected by poultry farmers included direct biological health effects such as hens laying fewer eggs or not thriving, nervous system problems in chicks, and a declining ratio of hatched eggs.

- May 27, 1999—The Belgian Ministry of Agriculture notified the public and the European Commission (EC) about the situation.

On May 28, 1999, Belgium banned the domestic sale of all Belgian-produced chicken, meat, and eggs, withdrawing these products from retail stores (Ashraf, 1999). Later the Belgian government widened the list of products potentially contaminated with dioxin (FAS, June 7, 1999). As a result of the crisis, more than 200 butcher shops closed temporarily in Belgium and consumers rushed to buy organic eggs and other products that were not suspect (FAS, June 7, 1999). Lok and Powell (2000) detail the actions the Belgian government took to mitigate and resolve the crisis.

On June 4, 1999, the U.S. Food and Drug Administration (FDA) issued an import bulletin to detain certain products at the port of entry. On June 11, 1999, FDA issued an import alert (No. 99-24) to detain certain products at ports of entry until importers provided lab test results showing that shipments were free of detectable levels of PCBs and/or dioxins (FDA, June 11, 1999). Products in this initial import alert included eggs, products containing eggs, game meats from Belgium, France, and the Netherlands, all animal feeds and feed ingredients, and pet foods from all European countries (FDA, June 11, 1999). This list was later expanded to include milk-containing products such as soups and cheese (FDA, June 23, 1999). The Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture (USDA) also issued import alerts and took subsequent actions. The U.S. import alerts from this crisis were canceled in early 2000 (personal communication with FDA on Sept. 21, 2000).

Within 2 to 3 weeks of the May 27 announcement, more than 30 countries issued different combinations of temporary consumer advisories, import bans, and import alerts of potentially contaminated foods and animals from Belgium, select EU countries, or the EU as a whole (Lok and Powell, 2000).[6] More products were added to the lists of suspected products as the crisis unfolded (e.g., chocolates) (Lok and Powell, 2000). Much later, the EU raised objections to the emergency measures of nine of its trading partners who maintained restrictions on animal products when these actions were no longer justified in the view of EU officials (see chapter 3).

As dioxin risks are long-term health hazards and hard to detect and attribute to specific causes, it will take time to determine if international measures to mitigate the crisis were successful in terms of protecting human health: to date, no human illnesses have been linked to this incident. Van Larebeke et al. (2001) estimate that the stochastic incremental cancer risk associated with the Belgian PCB and dioxin crisis varies between 44 and 8,316 cancer deaths in the Belgian population (roughly 10 million). They caution that huge uncertainties exist with their estimates, such as the pathogenic potency of the PCBs and dioxin.

## Estimated Economic Impacts of the Belgium Dioxin Crisis

Ideally, an economic analysis of the Belgium dioxin crisis would require careful evaluation of the: (1) domestic products that are directly and indirectly affected by the contamination, (2) agricultural sectors providing these products to domestic and international markets, and (3) shortrun and longrun effects of the crisis. For example, costs from the crisis would include costs from new regulations for feed ingredients. However, it would be difficult to estimate these costs as BSE and foot and mouth disease also likely contributed to such legislation (FAS, 2003). Because of data availability and the more descriptive goals of this chapter, we focus here almost exclusively on the direct effects of the crisis on Belgian food production and exports in select markets or sectors.

### Estimated Impact on Exports

To analyze the impact of the Belgian dioxin crisis on Belgium-Luxembourg exports of agricultural products, we aggregated data from the United Nations Statistics Division on agricultural products into five product categories: dairy, swine, "other meat" (i.e., nonswine and nonpoultry), and poultry products, and eggs (see attachment A).

In general, Belgian exports of dairy products far exceed other categories of Belgian agricultural exports (table 8.1). Between 1990 and 1995, the exports of dairy products grew steadily and then showed a few years of declining exports. Part of the

[6] For example, countries that took action included Australia, Canada, Cyprus, Germany, Hong Kong, Portugal, Russia, Saudi Arabia, Singapore, South Africa, and Thailand.

**Table 8.1—Belgium-Luxembourg world exports of key agricultural products, 1989-99**

| Product category | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | — *Metric tons* — | | | | | |
| Dairy products | 1,184 | 1,156 | 1,402 | 1,586 | 1,586 | 1,719 | 1,890 | 1,711 | 1,622 | 1,741 | 1,676 |
| Swine products | 391 | 382 | 459 | 482 | 540 | 562 | 604 | 630 | 635 | 685 | 588 |
| Meat products[1] | 176 | 198 | 234 | 239 | 271 | 259 | 262 | 281 | 333 | 308 | 209 |
| Poultry products | 68 | 81 | 98 | 123 | 149 | 160 | 188 | 218 | 293 | 328 | 335 |
| Eggs | 89 | 94 | 93 | 98 | 83 | 110 | 108 | 105 | 127 | 118 | 111 |

[1] Here "meat" refers to meat other than swine and poultry.

Source: Computed from United Nations Statistics Division's COMTRADE database, 2002.

drop between 1998 and 1999 is likely due to the Belgium dioxin crisis because many countries, including the United States, banned the import of milk products from Belgium. Exports of swine products and "other meat" products also dropped between 1998 and 1999. Poultry exports grew consistently over this time period while egg product exports changed little (fig. 8.1).

To more closely analyze the short-run economic effects of the Belgian dioxin crisis, we compared the longrun growth of exports of eggs and poultry, swine, other meat, and dairy products over the decade prior to the 1999 crisis against the shortrun effects, as measured by the percent change in exports between 1998 and 1999 (table 8.2 and fig. 8.2). These data suggest that the Belgium dioxin crisis had a shortrun economic impact on the export market. The estimated growth rates for the 10 years between 1989 and 1998 were positive for all five product categories. However, between 1998 and 1999, the growth rate dropped and became negative for eggs, swine, and dairy products, with the largest decline for other meat. The change in poultry exports between 1998 and 1999 remained positive but dropped dramatically from its longrun growth rate of 19.1 percent.

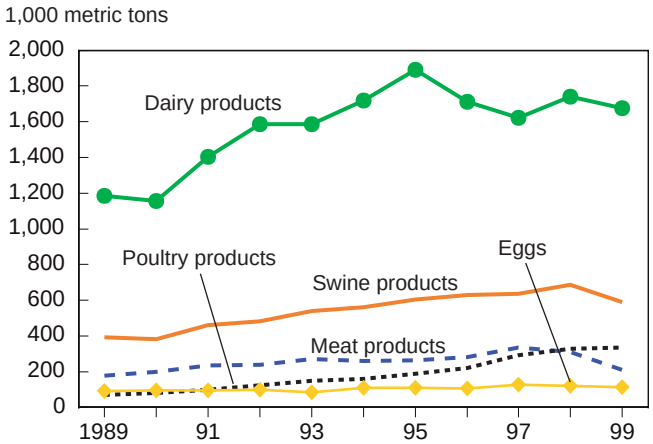
**Table 8.2—Comparison of the growth of Belgium-Luxembourg exports of key agricultural products**

| Product category | Rate of growth (1989-99) | Change of growth (1998-99) |
|---|---|---|
| | *Percent* | |
| Eggs | 3.1 | -6.0 |
| Meat products | 6.5 | -32.1 |
| Swine products | 6.4 | -14.2 |
| Dairy products | 4.4 | -3.7 |
| Poultry products | 19.1 | 2.3 |

Source: Computed from United Nations Statistics Division's COMTRADE database, 2002.

Figure 8.1

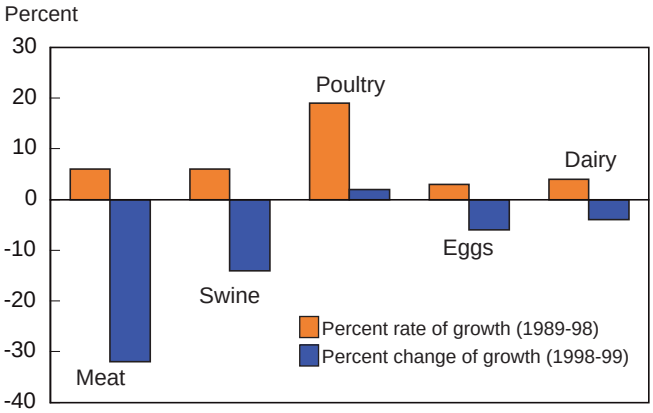
**Belgium-Luxembourg world exports of key agricultural products**




Source: Computed from United Nations Statistics Division's COMTRADE database, 2002.

Figure 8.2

**Comparison of the growth of Belgium-Luxembourg world exports of key agricultural products using percent rate of growth between 1989-99 and 1998-99**




Source: Computed from United Nations Statistics Division's COMTRADE database, 2002.

The Belgium Foreign Trade Bulletin (FGTB) reports that "it is interesting to note that the statistical data for September, October, November, and December show a recovery in exports, so that it seems that the effects of the dioxin crisis had become virtually nonexistent by then."[7] Any estimation of the exact amount of the long-run effect on exports will require more detailed data for a longer time period for these industries and other directly and indirectly affected industries.

## Estimated Impacts on Production

The Belgian Ministry of Economic Affairs, National Institute of Statistics (NIS) conducted a study on the impact of the dioxin crisis on meat production (1999). Data in this report were based on an index of production per working day (1995=100). The NIS report (1999) compared the change in production, processing, and preserving of key agricultural products in Belgium during the first 9 months of 1999 with data for the first 9 months in 1998. Although the dioxin contamination began in January 1999, the major impacts were felt in June, immediately after the Belgium public, the EU, and the rest of the world were notified of the crisis in late May. Overall, when considering the relative importance of the different subsectors, the dioxin crisis caused an estimated decrease in total food industry production of 10 percent in June 1999, 2.5 percent in July and August, and 1.5 percent in September (NIS, 1999). If construction is excluded, the net impact on the total food industry was a decline of 1.2 percent, 0.3 percent, 0.3 percent, and 0.2 percent respectively for the months June through September (NIS, 1999).

Here we take a closer look at 6 of the 15 agricultural sub-sectors in the NIS report, those that were either directly and adversely affected or profited from the crisis:[8]

1) Poultry meat products,
2) Meat and meat products,
3) Slaughtering of cattle,
4) Dairies and cheese making, and
5) Fish and fish products,
6) Prepared feeds for farm animals.

Monthly production indices (1998-99) for each of these six product categories are provided in attachment B. Table 8.3 presents the change in the production index for each product category for the first 9 months of 1999 from its corresponding index for the first 9 months of 1998. We developed figure 8.3 so that the impacts from the crisis and patterns of change for these six categories could be more easily identified and compared.

In general, the three meat industry categories (poultry meat production, meat and meat product production, and slaughtering of cattle) were the subsectors hit hardest in terms of declines in monthly production/processing and preserving. Clearly, the sharpest production declines occurred in June 1999, right after the public announcement about the crisis in late May. An analysis of the long-term effects of the crisis would require more recent data. However, the worst impacts for all six categories seemed to be over in July 1999 with the different subsectors gradually returning to pre-crisis levels over subsequent months.

Poultry meat products had the steepest drop in the data series, 53.5 percent lower in 1999 than in 1998. This is not surprising because the first bans resulting from the crisis included the domestic sales of Belgian-produced chicken meat and egg products and exports of Belgian chicken products. Although one might expect a larger drop for feed production, the amount of feed contaminated by dioxins was small compared with that produced and used each week in Belgium, and the feed that was contaminated was distributed widely, mostly to poultry producers.

There were negative percent (index) changes during the entire first 9 months of 1999 for the production, processing, and preserving of meat and meat products. This is consistent with the declining trend in the demand for these products. During 1995-98, consumption of fresh meat in Belgium declined heavily, as it did in most of the other EU countries (Verbeke and Ward, 2001). In particular, the gradual long-term decline in per capita beef consumption is likely caused by long-term changes in the eating habits and demographics of EU consumers (EC, 1997; EC, 1998; see chapter 4). However, the largest drop in Belgian production of meat and meat products was observed during June 1999 (-42.4 percent). The decreased cattle slaughter was likely a function of several factors such as temporary slaughter bans, which kept many animals on the farms.

[7] Source: BFTB - Statistics / Annual Study Belgium's Foreign Trade in 1999. URL: *www.obcebdbh.be/import_en/info-centerr/trade-statistics/annual-study/1999/as-sbreakdown_en.html*

[8] Other categories not covered here include a wide range of products such as beverages, tobacco, cocoa, bread, condiments, and seasoning.

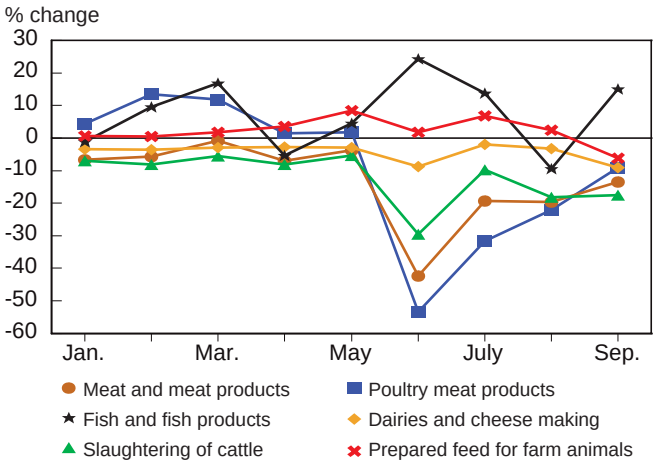
**Table 8.3—Monthly change in Belgium-Luxembourg production/processing and preserving of agricultural products indices between 1998 and 1999**

| Product category | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Percent* | | | | |
| Poultry meat products | 4.3 | 13.4 | 11.9 | 1.5 | 1.8 | **-53.5** | -31.6 | -22.1 | -9.1 |
| Meat and meat products | -6.6 | -5.7 | -0.9 | -7.0 | -3.8 | **-42.4** | -19.3 | -19.7 | -13.5 |
| Slaughtering of cattle | -7.0 | -8.1 | -5.6 | -8.2 | -5.4 | **-29.5** | -9.8 | -18.2 | -17.6 |
| Dairies and cheese making | -3.4 | -3.6 | -3.0 | -2.7 | -2.9 | **-8.7** | -2.0 | -3.2 | -9.1 |
| Fish and fish products | -1.1 | 9.6 | 16.8 | -5.4 | 4.6 | **24.4** | 13.8 | -9.5 | 15.1 |
| Prepared feeds for farm animals | 0.7 | 0.5 | 1.8 | 3.5 | 8.5 | **1.7** | 6.8 | 2.4 | -6.1 |

Source: Belgium Ministry of Economic Affairs, National Institute of Statistics, 1999.

Figure 8.3

**Monthly change in Belgium-Luxembourg production/processing and preserving of agricultural products indices between 1998 and 1999**




Source: Belgium Ministry of Economic Affairs, National Institute of Statistics, 1999.

In the production category "dairies and cheese making," declines were more subtle and seemed to quickly return to monthly decreases. The NIS report considers this category one of the indirectly affected subsectors.

While several production categories showed marked declines after the announcement, others, such as fish and fish products, showed increased production and profited from the dioxin problem. Monthly changes for fish and fish products show some natural fluctuation, perhaps due to seasonal changes or harvest factors. However, the June 1999 index was 24.4 percent higher than in June 1998. This likely reflects consumers' belief that these food products posed lower risks from dioxin contamination, and consumers may have substituted fish products for meat and swine products. In particular, according to the U.S. Foreign Agricultural Service (FAS), Belgian seafood consumption rose 50 percent in June 1999 due to the crisis, with increased shellfish sales offsetting a decreased market for other kinds of seafood (FAS, June 13, 2001).

Another production category that appeared to benefit from the crisis, at least in the short run, was prepared feeds for farm animals. The July increase was likely due to the temporary slaughter ban that kept many animals on the farms, creating a greater demand for animal feeds (NIS, 1999). Although the dioxin contamination originated in animal feeds, other production sectors were far more affected in percentage terms.

The Belgian swine industry suffered when test results in June 1999 confirmed dioxin contamination of swine on some farms (FAS, Aug. 1, 1999). Contaminated swine farms were depopulated. On other farms, swine facilities became overcrowded because of reduced demand, adding unnecessary feed costs, limiting stable space, and prohibiting fatteners from buying piglets and starting new fattening cycles. Increased quantities of pork were put into storage because of reduced markets. The Belgian pork sector received limited financial aid from the Belgian government for this crisis and received no financial aid from the European Commission (FAS, Aug. 1, 1999).

## Summary of Impacts

The combination of slaughter bans, large price concessions, and reduced markets after the dioxin crisis posed an economic burden on consumers, food producers, and food exporters. On August 16, 2003, the EC approved a Belgian aid agreement that would reimburse farmers 80 percent of market price of their losses (Lok and Powell, 2000). The Belgian government estimates that the dioxin crisis cost €465 million ($493 million), with about €100 million ($106 million) attributed to the loss in the swine sector (where 1999 €1.00= US$ 1.06) (FAS, Feb. 1,

2001, pg. 18, 19).[9] And as other EU countries were also affected by export bans, the cost of this incident worldwide will likely be higher.

The economic impact of the Belgian crisis was relatively small compared with the Belgium economy's GDP (1999) of $266 billion in 1999, but was important for agriculture, which accounted for 1.4 percent of GDP or $3.7 billion.[10] In 2000, on the heels of the Belgian dioxin crisis, Belgium confirmed its first case of bovine spongiform encephalopathy (BSE). This BSE crisis cost Belgium an additional €250 million (FAS, Feb. 1, 2001) (chapter 4 provides more details on BSE).

These costs of the dioxin crisis are, however, offset to some extent by gains obtained in industries and countries that provided substitute products. In response to the Belgian dioxin scare and the temporary removal of some food products from Belgian supermarkets, Belgian consumers became more concerned about food safety and many began consuming more produce, organic eggs, and other organic products. The dioxin crisis also prompted increased consumption of mutton, lamb, and horsemeat (FAS, April 17, 2000). The clearest example of a Belgian food industry that profited from the dioxin crisis is the appreciably increased production of "fish and fish products" [includes shellfish] in June and July 1999 (NIS, 1999). And, in the German market, there appears to have been temporarily increased demand for pork and slaughter hogs (FAS, Aug. 1, 1999).

Although one might expect that food imports may have helped reduce or mitigate some of the impacts of the Belgian dioxin crisis on the domestic economy, United Nations trade statistics for 1989-2001 show that meat imports into Belgium-Luxembourg actually fell in 1999 from its 10-year high. The fall in meat imports in 1999 likely reflects, in part, the decreased demand for meat following the crisis. For example, per capita consumption of beef and veal in Belgium also decreased in 1999, probably partly due to the dioxin crisis (FAS, Feb. 1, 2001, p. 7).[11]

[9] Of this amount, €165 million was for the Ministry of Agriculture and €300 million was for the Ministry of Public Health (FAS, Feb. 1, 2001). No further description was provided in the publication.

[10] *www.state.gov/www/background_notes/belgium_0006_bgn.html*, accesssed May 17, 2002.

[11] Pork consumption also fell in 1999 due to the dioxin crisis (FAS, Feb. 1, 2001, p. 14) and live pig exports increased considerably, particularly to Dutch slaughterhouses (FAS, Feb. 1, 2001, p. 14). Another factor affecting pork production is EU legislation against nitrate emissions (FAS, Feb. 1, 2001, p. 13).

## Public and Private Sector Response

As with the BSE crisis, the dioxin scare illustrates that a food safety crisis can impose high financial and political costs on industries and countries. The Public Health Minister and the Agriculture Minister resigned after if became clear that the Belgian government had known about the dioxin crisis for weeks before announcing it to the public and the EC (Ashraf, 1999). The Dutch Minister of Agriculture also resigned after similar criticism (Lok and Powell, 2000). Public confidence in both the food supply and the Belgian government was shaken and, partly because of this, the ruling party was later ousted in a national election (Lok and Powell, 2000).

In addition to mitigation actions, the dioxin crisis and general concerns about dioxins resulted in several responses by the public sector. First, the Belgian government created a new agency called the Federal Agency for Safety of the Food Chain in response to the lack of public communication and internal mechanisms that exasperated the crisis (FAS, Aug. 17, 2000). This new agency has broad responsibilities that ensure food safety from farm to table and once fully implemented, it will be placed under the Ministry of Public Health (FAVV, 2002).[12] Second, this new agency instituted a traceability and monitoring system to extend the existing SANITEL system for the mandatory identification of cattle. A meat traceability component extends the system to other animals and beyond the slaughterhouse (BELLTRACE) and a monitoring component—Contaminant Surveillance System (CONSUM)—tests for chemical and microbiological contamination of feedstuffs and all animal food products such as eggs, oils, fats, dairy, fishery, and derived products (FAS, Nov. 5, 2001). The goal of this monitoring system is early detection of contamination. Third, the Belgian government will execute certain decisions taken by the EC concerning dioxins.

For example, the EC asked the EU's Standing Committee on Animal Agriculture and Nutrition (SCAN) and the Scientific Committee on Food (SCF) for scientific opinions about the contamination of feed and food by dioxins and closely related PCBs. As a

[12] Previously, food safety in Belgium was controlled by five agencies and is now covered instead by one new agency that falls under the authority of the Ministry of Public Health. See FAS June 26, 2000 report for details on the agency's seven assignments.

result, two reports were released in November 2000. The SCF report established a temporary tolerable weekly intake (TWI) for dioxins and dioxin-like PCBs of 14 pg/kg body weight (EC, Nov. 22, 2000). These were updated on May 30, 2001. Meanwhile, the SCAN report's main conclusion is that fish oil and fishmeal are the most heavily contaminated feed materials, followed by animal fat (EC, Nov. 6, 2000). The report recommended an emphasis on reducing the most contaminated materials. Both reports recommended an integrated approach that would reduce dioxin contamination all along the food chain, a more systematic and coordinated generation and collection of comparable and reliable data, and a continuing reduction of emissions to the environment.

Given these two reports and an earlier White Paper on Food Safety that identified the need to set standards for contaminants in feed and food (EC, Jan. 12, 2000), the EC proposed a strategy to reduce dioxin in animal feed, the environment, and food in July 2001 (EC, July 20, 2001). In October 2001, the EC adopted this strategy (EC, Oct. 25, 2001). In essence, this strategy has two parts. The first part identifies short to medium-term (5 years) and long-term (10 years) actions that combined are intended to provide a comprehensive understanding of the dioxin/PCB problem and existing trends to assist future evaluation and policymaking. The second part has three components: (1) *maximum levels* to set regulatory limits for dioxin in foods and feeds, (2) *action levels* to serve as early warning indicators of undesirable dioxin levels so measures can be taken to eliminate the sources and pathways of contamination, and (3) *target levels* to bring food and feed, over time, down below the SCF's recommended TWI of 14 pg/kg body weight for dioxins.

The U.S. government also monitors potential dietary sources of dioxins. Since 1995, the FDA has tested several hundred samples a year, primarily fish and foods sold at retail outlets (FDA, 2000). Meanwhile, EPA and the FSIS test for dioxins in U.S. beef, pork, and poultry. In 1999, as part of the Total Diet Study, FDA started dioxin monitoring in 200 of the most commonly consumed foods in the United States (FDA, 2000). The U.S. also began monitoring animal feeds that may contribute to the dioxin levels in some foods (FDA, 2000). FDA's monitoring program has been successful in identifying elevated levels of dioxin in some mineral components of animal feed and is taking action to stop distribution of any contaminated product (for example, see FDA, February 28, 2003).

## Dioxin Crisis and Belgian Consumers

During the crisis, Belgian consumers switched to other food products to avoid dioxin-contaminated products either voluntarily or as a result of limited access to foods in supermarkets and stores. Some apparently crossed into England, France, or Germany in search of untainted food. Meanwhile, some Belgian towns opened dump sites so that local residents could leave suspect foods for destruction (BBC news, June 5, 1999).

The dioxin crisis caused a high awareness and anxiety about food safety in Belgium that served as background stress for consumer reaction to another scare, this time over Coca-Cola (Nemery et al., 1999). Within a month of the announcement about the dioxin crisis, schoolchildren and others across Belgium began complaining about nausea, headaches, and other symptoms that they believed were caused by drinking bottled Coca-Cola. There were never any significant lab or physical findings to support these claims and some people believed that features of this outbreak pointed to mass hysteria or mass sociogenic illness (Nemery et al., 1999).[13] There was intense media coverage about the Coca-Cola scare on the tails of intense media coverage about the dioxin incident.

# Conclusion

The Belgian dioxin crisis illustrates that an international food safety crisis can have significant, short-term impacts on the implicated industries and the exporting country. The dioxin crisis affected a large array of agricultural industries in Belgium (e.g., feed, meat, poultry, cattle slaughter, dairy and cheese making) and interrupted trade with the United States and more than 30 other countries (Lok and Powell, 2000). The crisis also illustrates how consumers react to crises in the short run, switching to nonsuspect products (e.g., organic eggs). More recent data and more research are needed to clarify if there are longrun impacts from the crisis, the extent of such impacts, and whether the possibility that the contamination could have been intentional (in some way) had any impact on consumer food safety perceptions.

[13] Mass sociogenic illness "can be defined as a constellation of symptoms of an organic illness, but without identifiable cause, which occurs among two or more persons who share beliefs related to those symptoms" (Philen et al., 1989).

As a result of this crisis, Belgium took multiple actions to minimize the spread of the contamination, resolve the problem, and be better prepared for similar crises (e.g., creation of a single federal agency to cover food safety from farm to table). However, the month-long period between when the government was first notified of the problem and when it was publicly announced was seen as irresponsible by many stakeholders and therefore, the Belgian government lost credibility, trust, and authority and received little credit for all the positive and proactive measures that were taken (Lok and Powell, 2000). Despite the government's explanation that the delay was to first confirm whether the dioxin had entered the human food supply, by the time of this explanation, criticism and discussion focused on the government instead of on those responsible for the contamination or on the extant regulation, surveillance, and enforcement that allowed the crisis to occur (Lok and Powell, 2000).

In general, many factors come into play in the identification of a food safety crisis, including the existing surveillance systems and the way that the contamination manifests itself in animals and humans (e.g., declining ratio of hatched eggs, time to develop acute or chronic illness in humans). On the one hand, the financial stakes of erroneously announcing a crisis can be high, so regulators have some reason to be cautious about prematurely alerting the public and trading partners about a potential crisis until there is sufficient, accurate information on the source, extent, and risk posed by the crisis. For example, the California Strawberry Commission estimated that growers in the central coast of California lost $16 million in revenue to during June 1996 when their products were falsely implicated as the cause of the *Cyclospora* outbreak later attributed to Guatemalan raspberries (Mishen, 1996) (see chapter 5). On the other hand, a greater time lag between the initial contamination and its identification and control can extend and magnify the impacts of a food safety crisis on production, trade, and consumption. And, any public information lag about a potential food safety crisis can be a point of criticism used against governments.

A persistent challenge in major food safety crises will be the fine balance between gathering sufficient, accurate information on such an event (e.g., source, cause, human and animal health risks) and the timely release of information to the public and trading partners. Overcoming this challenge will be important for governments and implicated industries to minimize damage to food markets and maintain consumer confidence in both the food supply and in governments' ability to handle food safety crises.

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## Attachment A—Belgian-Luxembourg exports, 1989-1999

| Products | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Metric tons* | | | | | |
| **Meat products** | | | | | | | | | | | |
| Bovine meat,fh,ch,w.bone | 95,803 | 110,098 | 123,608 | 117,085 | 111,447 | 94,805 | 86,958 | 80,303 | 83,850 | 74,097 | 59,686 |
| Bovine meat,fh,ch,bnless | 8,753 | 16,012 | 14,065 | 11,228 | 13,418 | 11,718 | 12,894 | 12,778 | 14,988 | 14,735 | 18,413 |
| Bovine meat,frozn,w.bone | 4,680 | 1,089 | 1,566 | 5,831 | 3,461 | 981 | 988 | 3,344 | 4,519 | 2,291 | 2,141 |
| Bovine meat,frz,boneless | 7,579 | 10,197 | 23,548 | 28,303 | 35,441 | 33,395 | 39,983 | 42,082 | 36,044 | 21,651 | 13,528 |
| Meat of sheep,frsh,chlld | 2,648 | 2,947 | 2,602 | 2,393 | 1,803 | 1,570 | 2,348 | 1,283 | 2,064 | 2,744 | 4,248 |
| Meat of sheep, frozen | 1,966 | 1,572 | 1,502 | 1,576 | 3,613 | 6,192 | 7,254 | 5,406 | 6,532 | 8,155 | 9,604 |
| Meat of goats | 10 | 4 | 24 | 56 | 2 | - | - | 3 | 3 | 1 | 1 |
| Meat of horses,mules,etc | 10,160 | 10,198 | 12,377 | 13,523 | 22,934 | 23,831 | 22,493 | 29,281 | 30,315 | 29,735 | 8,127 |
| Edible offal,bov.frsh,ch | 1,843 | 2,364 | 2,028 | 2,583 | 6,051 | 5,797 | 9,666 | 10,126 | 10,929 | 15,554 | 3,621 |
| Edible offal,bov.,frozen | 4,791 | 5,461 | 7,950 | 9,441 | 10,175 | 10,050 | 9,999 | 12,281 | 10,802 | 7,126 | 23,699 |
| Ed.off.sheep,horse,fh,ch | 137 | 211 | 134 | 43 | 127 | 91 | 114 | 134 | 144 | 255 | 765 |
| Ed.off.sheep,horse,frozn | 307 | 472 | 250 | 440 | 324 | 430 | 360 | 481 | 614 | 789 | |
| Meat,ed.off,rabbit,hares | 1,675 | 1,473 | 965 | 1,719 | 1,914 | 1,371 | 1,265 | 1,387 | 1,740 | 1,975 | 1,671 |
| Other meat,edible offal | 210 | 338 | 333 | 429 | 2,712 | 3,404 | 1,152 | 1,440 | 1,824 | 2,595 | 3,944 |
| Bov.meat,dried,smkd,salt | 323 | 341 | 434 | 263 | 208 | 161 | 179 | 74 | 48 | 15 | 18 |
| Oth.mt,off.flr.dr,sk,slt | 750 | 694 | 616 | 603 | 592 | 1,594 | 1,763 | 6,270 | 6,120 | 6,469 | 970 |
| Extract,juice meat,fish | 76 | 26 | 119 | 75 | 29 | 77 | 284 | 75 | 193 | 140 | 143 |
| Sausage of meat,offl.etc | 10,315 | 11,057 | 15,661 | 16,490 | 31,142 | 34,360 | 35,611 | 48,548 | 90,626 | 87,611 | 31,676 |
| Liver,preprd,presrvd,nes | 19,590 | 18,276 | 21,040 | 21,486 | 20,348 | 21,482 | 22,560 | 21,167 | 24,628 | 26,422 | 20,241 |
| Bov.meat,prpd,prsrvd,nes | 2,402 | 2,717 | 2,986 | 3,361 | 3,253 | 5,945 | 4,053 | 3,016 | 4,561 | 4,121 | 4,676 |
| Oth.meat,prpd,prsrvd nes | 1,679 | 1,972 | 2,340 | 2,325 | 2,240 | 1,698 | 1,756 | 1,803 | 2,206 | 1,998 | 2,266 |
| **Swine products** | | | | | | | | | | | |
| Meat of swine,frsh,chlld | 163,253 | 164,759 | 225,308 | 255,158 | 303,100 | 312,721 | 380,216 | 389,984 | 375,100 | 422,131 | 400,652 |
| Meat of swine, frozen | 127,924 | 113,315 | 122,308 | 111,642 | 108,060 | 120,409 | 100,011 | 103,040 | 100,301 | 102,969 | 94,898 |
| Edible offal,swine,fh,ch | 3,740 | 3,555 | 4,724 | 6,007 | 14,476 | 12,928 | 13,596 | 19,036 | 24,564 | 27,200 | 20,494 |
| Edible offal,swine,frzen | 17,546 | 17,336 | 17,872 | 20,894 | 20,695 | 25,518 | 23,130 | 24,449 | 29,002 | 31,743 | 218 |
| Hams,shoulders with bone | 2,683 | 2,118 | 1,934 | 1,641 | 2,944 | 2,087 | 1,607 | 2,022 | 1,895 | 2,042 | 1,893 |
| Bellies (streaky) | 5,496 | 4,969 | 5,029 | 4,006 | 6,493 | 7,419 | 5,883 | 7,092 | 7,186 | 7,433 | 6,635 |
| Oth.pigmeat,dry,salt,smk | 20,209 | 17,974 | 18,431 | 15,638 | 13,597 | 12,488 | 12,618 | 13,484 | 14,286 | 12,223 | 10,580 |
| Pork,prepred,presrvd,nes | 49,968 | 58,022 | 63,839 | 66,734 | 70,205 | 68,847 | 67,009 | 71,081 | 82,199 | 79,709 | 52,911 |
| **Poultry products** | | | | | | | | | | | |
| Poultry,whole,frsh,chlld | 4,692 | 9,086 | 11,311 | 13,651 | 18,734 | 18,372 | 17,128 | 21,617 | 25,405 | 27,868 | 28,598 |
| Poultry,whole, frozen | 24,076 | 23,878 | 26,379 | 29,396 | 29,821 | 23,792 | 21,305 | 19,559 | 26,313 | 27,625 | 19,577 |
| Liver,goose,duck,fh,chll | 567 | 467 | 429 | 179 | 337 | 222 | 135 | 107 | 340 | 226 | 329 |
| Poultry,parts,frsh,chlld | 19,407 | 24,417 | 32,671 | 44,233 | 53,674 | 55,613 | 62,189 | 70,339 | 101,174 | 115,008 | 111,551 |
| Poultry,prts,frzn.ex.liv | 15,222 | 17,564 | 19,217 | 25,292 | 34,713 | 46,949 | 69,532 | 84,304 | 112,687 | 130,182 | 123,283 |
| Poultry livers, frozen | 114 | 309 | 498 | 558 | 812 | 796 | 703 | - | - | - | 28,843 |
| Poultry,prprd,prsrvd,nes | 4,052 | 5,010 | 7,815 | 9,709 | 10,706 | 13,919 | 17,303 | 22,420 | 26,905 | 26,609 | 22,903 |
| **Eggs** | | | | | | | | | | | |
| Birds' eggs, in shell | 47,730 | 49,207 | 47,963 | 52,991 | 42,293 | 71,956 | 66,493 | 70,359 | 82,115 | 76,431 | 76,226 |
| Egg,unshelld;yolks,dried | 664 | 893 | 1,175 | 1,117 | 1,728 | 2,177 | 1,343 | 1,848 | 3,477 | 3,488 | 4,295 |
| Egg,unshelld;ylk,not dry | 32,690 | 37,022 | 36,015 | 34,552 | 29,876 | 24,476 | 30,142 | 22,358 | 27,624 | 25,872 | 19,340 |
| Egg albumin | 8,348 | 6,770 | 8,275 | 9,147 | 9,358 | 11,213 | 10,444 | 10,647 | 13,302 | 11,950 | 10,798 |

*--Continued*

## Attachment A—Belgian-Luxembourg exports, 1989-1999--Continued

| Products | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Metric tons* | | | | | |
| **Dairy products** | | | | | | | | | | | |
| Milk,fat cont.1% or less | 112,910 | 108,801 | 136,778 | 117,727 | 109,296 | 109,303 | 117,855 | 89,192 | 102,680 | 93,358 | 68,845 |
| Milk,cream fat cont.1-6% | 513,589 | 478,418 | 564,070 | 693,685 | 683,570 | 801,064 | 823,817 | 779,161 | 682,509 | 690,327 | 693,046 |
| Cream,fat content 6%+ | 23,402 | 18,186 | 21,645 | 33,628 | 21,850 | 34,248 | 30,397 | 45,477 | 45,926 | 91,210 | 93,388 |
| Milk,solid, to 1.5% fat | 84,832 | 63,038 | 83,660 | 90,003 | 102,217 | 76,406 | 150,836 | 88,946 | 65,808 | 62,361 | 90,491 |
| Milk,crm solid 1.5%+ fat | 36,126 | 34,430 | 69,614 | 72,173 | 99,578 | 119,699 | 176,401 | 115,213 | 92,427 | 90,237 | 71,961 |
| Milk,cream unsweetened | 20,370 | 30,875 | 41,327 | 62,800 | 24,765 | 25,477 | 28,560 | 18,271 | 34,342 | 78,552 | 54,366 |
| Milk,cream, sweetened | 12,576 | 16,626 | 20,423 | 20,940 | 20,057 | 11,936 | 20,329 | 16,185 | 12,239 | 12,854 | 15,663 |
| Yogurt | 34,675 | 47,892 | 62,897 | 73,052 | 90,978 | 85,281 | 90,533 | 106,609 | 122,552 | 142,647 | 165,474 |
| Buttermilk | 9,731 | 12,414 | 11,365 | 14,184 | 18,370 | 30,762 | 37,597 | 44,828 | 40,642 | 36,063 | 32,538 |
| Ice cream | 58,694 | 63,856 | 69,690 | 60,955 | 62,692 | 69,319 | 68,151 | 68,636 | 75,842 | 90,454 | 92,927 |
| Whey | 102,768 | 103,497 | 106,480 | 122,462 | 94,220 | 66,948 | 76,097 | 78,660 | 94,564 | 88,949 | 56,171 |
| Milk products nes | 452 | 1,355 | 734 | 11,914 | 24,546 | 53,470 | 29,264 | 40,833 | 31,349 | 30,670 | 15,159 |
| Butter,other fat of milk | 116,658 | 107,278 | 132,469 | 119,244 | 133,541 | 127,367 | 125,094 | 105,345 | 111,332 | 116,825 | 107,338 |
| Cheese, powdered, grated | 207 | 430 | 522 | 907 | 971 | 1,085 | 1,566 | 919 | 1,082 | 1,948 | 3,523 |
| Processed cheese, whole | 29,622 | 39,383 | 45,490 | 51,793 | 54,016 | 48,937 | 49,036 | 49,892 | 51,730 | 51,709 | 51,601 |
| Blue-veined cheese | 418 | 425 | 453 | 492 | 540 | 461 | 416 | 305 | 325 | 357 | 443 |
| Fresh cheese,unfermented | 794 | 1,290 | 1,232 | 1,616 | 2,088 | 6,302 | 6,516 | 5,449 | 7,345 | 10,975 | 10,226 |
| Other cheese, curd | 25,703 | 28,223 | 33,204 | 38,400 | 42,657 | 50,732 | 57,301 | 57,445 | 49,187 | 51,461 | 53,034 |

Source: United Nations Statistics Division, COMTRADE database, 2000.

## Attachment B—Belgium-Luxembourg monthly production indices of key agricultural products, 1998-99

| Product category | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. |
|---|---|---|---|---|---|---|---|---|---|
| **Production, processing, and preserving of meat and meat products** | | | | | | | | | |
| Year 1998 | 128.7 | 121.9 | 127.3 | 132.6 | 135.3 | 130.2 | 122.4 | 119.5 | 120.3 |
| Year 1999 | 120.2 | 115.0 | 126.1 | 123.3 | 130.2 | 75.0 | 98.8 | 95.9 | 104.0 |
| % change from 1998 to 1999 | -6.60 | -5.66 | -0.94 | -7.01 | -3.77 | -42.40 | -19.28 | -19.75 | -13.55 |
| **Production and preserving of poultry meat** | | | | | | | | | |
| Year 1998 | 142.2 | 128.8 | 140.1 | 151.8 | 162.6 | 159.1 | 154.9 | 137.3 | 138.9 |
| Year 1999 | 148.3 | 146.1 | 156.8 | 154.1 | 165.5 | 74.0 | 105.9 | 107.0 | 126.2 |
| % change from 1998 to 1999 | 4.29 | 13.43 | 11.92 | 1.52 | 1.78 | -53.49 | -31.63 | -22.07 | -9.14 |
| **Slaughtering of cattle** | | | | | | | | | |
| Year 1998 | 109.7 | 100.9 | 108.5 | 106.8 | 103.5 | 100.4 | 90.1 | 94.2 | 101.4 |
| Year 1999 | 102.0 | 92.7 | 102.4 | 98.0 | 97.9 | 70.8 | 81.3 | 77.1 | 83.6 |
| % change from 1998 to 1999 | -7.02 | -8.13 | -5.62 | -8.24 | -5.41 | -29.48 | -9.77 | -18.15 | -17.55 |
| **Processing and preserving of fish and fish products** | | | | | | | | | |
| Year 1998 | 107.3 | 106.6 | 112.1 | 133.7 | 127 | 119.8 | 119.6 | 123.5 | 112.3 |
| Year 1999 | 106.1 | 116.8 | 130.9 | 126.5 | 132.9 | 149.0 | 136.1 | 111.8 | 129.3 |
| % change from 1998 to 1999 | -1.12 | 9.57 | 16.77 | -5.39 | 4.65 | 24.37 | 13.80 | -9.47 | 15.14 |
| **Operation of dairies and cheese making** | | | | | | | | | |
| Year 1998 | 109.7 | 101.8 | 109.8 | 107.1 | 107.6 | 104.5 | 85.7 | 89.6 | 99.3 |
| Year 1999 | 106.0 | 98.1 | 106.5 | 104.2 | 104.5 | 95.4 | 84.0 | 86.7 | 90.3 |
| % change from 1998 to 1999 | -3.37 | -3.63 | -3.01 | -2.71 | -2.88 | -8.71 | -1.98 | -3.24 | -9.06 |
| **Manufacture of prepared feeds for farm animals** | | | | | | | | | |
| Year 1998 | 120.5 | 111.8 | 119.3 | 121.4 | 114.3 | 111.8 | 111.4 | 109.8 | 110.3 |
| Year 1999 | 121.4 | 112.4 | 121.4 | 125.7 | 124.0 | 113.7 | 119.0 | 112.4 | 103.6 |
| % change from 1998 to 1999 | 0.75 | 0.54 | 1.76 | 3.54 | 8.49 | 1.70 | 6.82 | 2.37 | -6.07 |

Indices per working day (1995=100)

Source: Select production categories from the report by the Belgium Ministry of Economic Affairs, National Institute of Statistics titled "The Impact of the Dioxin Crisis on Belgian Production," 1999.