Chapter 5

Food Safety and Animal Health

Demand for animal food production is increasing as world population increases and developing countries have more disposable income. When marginal lands are included, livestock production uses more land than any other agricultural enterprise. Globally, however, production is shifting to more confined, concentrated and intensified systems. In North America, this intensification is regional, especially with poultry, swine and cattle feedlots. Dairies are becoming fewer and larger in size and are concentrating in areas not historically linked to dairy production. These changes have an ever increasing impact on animal and poultry health and the methods used to prevent and/or control diseases and parasites.

Globalization increases export opportunities for the North American livestock and poultry industries, but it also increases the risk for introducing a foreign animal disease that can be economically devastating. Even if an introduced disease is not deadly and is quickly contained, the economic impact could be significant if the result is a prolonged disruption of exports and trade with North America.

Maintaining food safety and assuring consumers of the safety of their food will continue to be challenges for the industry. The processing sectors have adopted process control strategies (Hazard Analysis and Critical Control Point, or HACCP) to reduce food-related risks. The production sector is adopting quality assurance programs and best management practices (BMPs) to address specific product quality and food safety issues. Advances in information technology and improved infrastructure to trace animal disease threats provide vehicles to share more product information through the supply chain. Individual firms may utilize the information infrastructure as part of an enhanced process control system.

Numerous facets to food safety and animal health issues are confronting North American animal agriculture. This chapter discusses the current situation and drivers of change, including issues that can be considered cross-cutting with respect to animal health and food safety concerns, government and policy issues, and emerging business strategies. It will then lay out options for the future, discuss the implications of each and conclude by identifying areas where additional research is needed.

Current Situation

Animal health and food safety issues are closely related. In some cases, the priorities of each are different enough to warrant separate strategies. Even if there are similarities in the approaches that address animal diseases and food safety, it is important to recognize that the objectives and desired outcomes are often different.

Cross-Cutting Issues

Traceability, Bioterrorism and Animal Disease: The ability to identify, track and sequester diseased animals and contaminated animal products is vital to secure the North American food system from accidental or intentional threats. Government and industry have common needs and uses for information from tracking systems. A partnership of government and private industry stakeholders will be needed to develop, implement and maintain functional, credible and reliable tracing systems, particularly in light of animal agriculture's dependency on export markets as engines for expansion and profitability.

An effective tracking system will enhance the industry's ability to compete effectively in global markets. Increasingly, global trade in animals and animal products accentuates the need for reliable disease identification and quarantine systems. This is especially true in high-income export markets, such as the European Union (EU) and the Pacific Rim, where consumer expectations and government regulations are raising the bar for traceability and identification of animal products. In addition to more favorable market positioning, a rapid animal identification tracking system would help mitigate potential losses from naturally occurring or terrorist-generated disease events. Animal and premise identifications are first steps in developing a rapid animal identification system.

Animal Disease and Public Health Interactions: Recent incidents of high pathogenic H5N1 strain of avian influenza in Southeast Asia, China and Europe and *bovine spongiform encephalopathy* (BSE) in Canada and North America have heightened fears of potential zoonotic diseases, i.e., those diseases that spread from animals to humans. These incidents have resulted in greater interaction between public health agencies and the veterinary

and medical professions. This increased coordination provides a foundation for proactive response to potential animal disease threats. The U.S. chicken industry, for example, has a testing program to ensure that chicken flocks, and the food products made from them, are free of potentially hazardous forms of avian influenza. Through comprehensive testing of all flocks, chicken companies will add another layer of safety to already existing measures to protect consumers and the food supply (Pretanik, 2006).

Organics: Organic agricultural products are a small but the fastest growing segment of the North American food products market. More farmers and ranchers are using organic production methods, and a majority of food retailers sell organic products. The U.S. market for organics is projected to be $30.1 billion by 2007. Organics represent only about 2 percent of food sales. Some consumers view organic products as being healthier and of better quality and are willing to pay higher prices for those perceived attributes (see Consumer Demand Chapter). Other consumers may view buying organic products as a way to support sustainable agriculture. Current demand indicates that there are opportunities for expanding organic production. Third-party certification of organic production systems, segregation of product from traditionally produced goods and traceability are the key elements of organic agricultural production. These characteristics may signal safer food supplies to some consumers. There is, however, no assurance that organic products are any "safer" than non-organics; in fact, they may be less safe from a pathogen perspective.

In Mexico, development of this market is growing, but is less developed than in Canada and the United States. A local capacity of assessment and verification of processes must be developed. This is an area of opportunity for cooperation among the NAFTA partners.

Residues: Consumers continue to express concern about antibiotic and chemical reside in foods. More restrictions on the use of antibiotics in food-producing animals may reduce concern in the general public over residues (USDA-AMS, 2005). The proliferation of claims about antibiotic use increases consumer confusion over undefined terminology such as "antibiotic free," "no antibiotic residues," "without added antibiotics" and "no sub-therapeutic antibiotics." The degree to which residue can be detected, combined with a lack of scientific understanding, may complicate the ability of consumers to assess risks. Continued improvements in detection methods for pathogens will enhance the ability of food firms to keep potentially harmful products out of the food supply chain.

Even when regulatory aspects have been developed, enforcement in Mexico is minimal and basically restricted in the case of meats to the Federal Inspection System plants, which represent only a small part of the slaughter. In milk, established firms and cooperatives have good control of residues. There is not a well-established consumer organization, and no such initiatives as advertising based on specific safety issues are observed. Therefore, in terms of the NAFTA region and its potential and capabilities to gain access to important markets outside the region, an effort should be made to minimize the differences among countries and identify agreed minimum standards.

Government and Policy Issues

Food Safety: Global production and marketing of animals and animal products have increased the risk of widespread animal disease. Canada, Mexico and the United States have systems in place to guard against the importation of plant and animal diseases, and to control naturally occurring disease outbreaks. Concern exists from Mexican officials, however, that "less than robust" food import inspection and enforcement capabilities in Mexico may result in shipments of "below standard" food products from the United States and Canada to Mexico.

In Mexico, both human health and agricultural authorities share food safety responsibilities, and there are many areas of intervention where specific coordination must be negotiated. The lack of clear-cut assignment of responsibilities favors the existence of regulatory loopholes that benefit dishonest wholesale traders and retailers. Effective coordination between the government agencies is not always negotiated or achieved. Clear-cut definitions or the creation of a single agency will be an important issue during the political campaigns leading up to elections.

Antibiotic Resistance: Consumers, trading partners and health professionals are concerned about the use of antibiotics. This is particularly true for those antibiotics used for growth promotion because of the potential development of resistance when used in low-dose regimens. Conversely, many people also believe that a reduction in antibiotic use will lead to more animal disease and higher levels of food epizootic pathogens, such as *Salmonella*, *Campylobacter* and *E. coli* in animal food products.

Animal Health Regulation: Science-based regulations are vital to a strong animal agriculture industry and will serve as a foundation to enhance domestic and international operations. A recent report by the National Academy of Sciences National Research Council recommends the United States establish a high-level mechanism to coordinate the currently fragmented regulatory framework for addressing new and emerging animal-borne diseases, e.g., BSE, avian influenza and West Nile Virus (National Research Council, 2005).

As a NAFTA region, a common robust system for epidemiological surveillance should be developed, which may include the strengthening of diagnostic capabilities. For Mexico,

it is advisable to reconsider updating the diagnostic laboratories network which once existed, and reinforcing capabilities for rapid response to animal health emergencies.

Trade and Market Accessibility: Consumers today desire a wide variety of foods throughout the year. To meet this diverse and year-round demand, many foods are produced outside of North America. This presents challenges for ensuring safe production practices, quality and food safety. Sanitary and Phytosanitary Standards (SPS) have become part of most trade agreements, but disputes over implementation can result in trade restrictions or embargoes on food products. The issue becomes more complex as trade expands and more regional trade agreements are established. Operation of local and regional markets, particularly those dealing in live animals, will continue to be a source of concern regarding animal health and will complicate full market accessibility within the North American Free Trade Agreement (NAFTA) (Nolen, 2002). As the North American market becomes more integrated and farmers and businesses in each NAFTA country become more interdependent, border issues become increasingly important. For example, about 100,000 Canadian pigs are transported to and fed weekly in the United States. Canada does not have the facilities to house and feed the pigs; if the border between the United States and Canada were to close, Canada would have difficulty dealing with these pigs. This further accentuates the need for harmonization of standards and enforcement within NAFTA.

Increased trade raises the issue of "pass-through" trade—products that originate in non-NAFTA countries and may meet SPS requirements in one NAFTA country, but not the country of final destination. Options include adoption of internationally equivalent animal health and food safety standards; NAFTA partners implementing similar levels of inspection; and consolidating food safety responsibilities in a single government agency. Canada, Mexico and the United States might consider establishing common North American disease restrictions for imports and exports of all animal species. Similarly, there are more well-defined criteria for trade stoppages due to disease and food safety concerns than there are for trade resumptions, a situation that will no doubt hamper full market integration among NAFTA trading partners. There is a need to manage trade in ways that cause the least disruption and increase the understanding of how NAFTA partners will treat each other in the event of a trade disruption. There is a high pay-off to market integration and, correspondingly, a high value to putting in place effective mechanisms to reopen borders after disease outbreaks or food safety incidents occur.

North American livestock products are considered to be among the safest, highest quality and most nutritious in the world. Despite this, there are periodic reports of pathogens or occasional recalls of contaminated products. Consumer perceptions of the existence of a problem, or the extent of its impact, may influence domestic or international market demand and producer profits.

Livestock Insurance and Indemnity: Animal disease outbreaks have the potential to be extremely damaging to the affected country's economy, through agriculture and agri-food product trade interruption, and/or loss of domestic consumer confidence. In the event of a crisis, the government would likely be under enormous pressure to provide financial disaster assistance.

In general, income support mechanisms in the agriculture sector are not specifically designed to address the sustainability of an entire industry when faced with closed export markets. Animal agriculture is more vulnerable than field crops because, except for dairy, it does not have the benefit of safety net farm policies. The fact that animal agriculture crises often are unforeseen and require quick responses generally results in government interventions that are reactive and discretionary. Despite all precautions, disease outbreaks will occur. Consideration of ways to protect the North American economy from the impacts of disease outbreaks may be needed.

Livestock insurance and indemnification of animals destroyed to control disease outbreaks are options to mitigate disease-related animal losses. Such programs must also consider the impact on price to all producers if export markets are lost due to an animal disease. Producers with healthy animals will still suffer economic losses. Initially, government agencies might have to provide subsidies for livestock insurance programs as they do for most crops. Such programs would be risk-management tools for animal producers and integrators. Current disease eradication plans have not considered the costs of dealing with surplus market animals.

A common NAFTA fund for livestock insurance and indemnity is one option to be considered.

Business Strategies

Source Verification: At present, private industry is implementing the most effective strategies for source verification. Many of these practices involve computerized production, receiving, inventory and shipment tracking through Radio Frequency Identification (RFID). In August 2005, the U.S. Department of Agriculture (USDA) approved the Age and Source Verification (ASV) program, enabling beef exports to Japan under specified conditions. Trade resumed in December 2005 only to be halted again in January 2006 due to one veal shipment in violation of requirements. Increasingly, suppliers of inputs to finished goods are required by their customers to have the capability to track the source of these inputs. Wal-Mart and other large multinational firms are the primary drivers of source verification. This is particularly true for products grown or

produced under specific contract stipulations, organics and boutique products, such as "antibiotic free," "pesticide free" and "humane practices" products.

While involved with many goods, large firms do not handle all products. For example, in Mexico, the majority of the domestic consumption of animal products is handled by small-scale retailers and traditional marketing systems, such as the *tianguis*. Developing a local capability to assess and verify specialized processes (e.g., organic products, pesticide-free, residue-free, non-GMO) is an area of potential cooperation among private-sector firms and NAFTA governments.

Recall Mitigation: U.S. and Canadian food firms continue to enhance their ability to voluntarily recall foods that fail to meet their internal quality standards, or fail to meet certain government-established standards. Many firms routinely implement mock recalls to improve their ability to respond quickly and efficiently. This practice increases the efficacy of recalls with respect to public health and helps preserve product and brand equity. In Mexico, only large firms have the capability to implement a food product recall on an emergency basis. Developing trademarks for unprocessed meats and animal products may enhance the capabilities of firms to conduct necessary targeted or widespread recalls.

Product Claims: In the United States, USDA and the Food and Drug Administration (FDA) have established specific criteria for product claims and product labeling in response to consumer demand for verification of claims. How food firms use such terms as natural, residue-free and humane in marketing products is the subject of debate. Policing these practices is limited. If public health remains unaffected and no laws are violated, it appears to be left to the market to determine appropriate product descriptions. Care must be taken to ensure that sanitary and health-related claims are confined to real and verifiable safety risks.

Homemade products remain outside the purview of most agencies, particularly in Mexico, where a large portion of agricultural products are sold in regional markets. Due to market structure and consumer behavior in Mexico, awareness of food product labels and product claims lags behind that of Canada and the United States. Product claims made in Mexico will advance consumer sophistication if they are verified by governmental agencies charged with this responsibility.

Cost Implications of Animal Health Management: Management and maintenance of animal health is a cost of doing business. Improvements in disease testing and continued vaccine research should eventually result in decreased costs. The initial cost of adopting technologies may involve additional fixed assets, but average variable and marginal costs should decrease as these technologies become fully operational, thereby decreasing the breakeven level for producers. Small producers may require special attention to improve their technological capabilities. Securing animal health for these producers is in the best interest of the entire animal agriculture industry and society as a whole.

Future Planning Strategy: Continued biotechnological advances should allow earlier administration of more protective vaccines to animals. One example is the in ovo technology currently used in the poultry industry that allows vaccination of chicks prior to hatching and then again at one day of age. This eliminates additional handling and reduces labor costs. Analogous to this practice would be in utero vaccination of other animal species. The development and adoption of these technologies may result in management strategy changes and precipitate industrywide operational changes.

Special effort should be made to provide small producers access to and support in the use of new technologies so that risk epidemiological niches do not develop.

Drivers of Change and Industry Responses

The majority of consumers consider domestically produced food to be safe. In a recent Gallup poll, 1,001 U.S. adults ranked restaurant, agriculture and grocery industries first, third and fourth, respectively, in terms of their trust of industries. High consumer confidence in the food system was also evidenced by the virtually imperceptible change in beef consumption related to the recent BSE incidents in Canada and the United States. The National Cattlemen's Beef Association (NCBA) and USDA worked cooperatively to address consumers' concerns regarding BSE by providing science-based information to the media and by encouraging clear communication between producers and the public. Processed foods are considered safe and as posing little threat to consumers, if properly handled and stored. Some consumers are concerned about chemical residues, the potential for antibiotic resistance of human pathogens resulting from prophylactic dosages in animals, and issues such as biosecurity and zoonotic diseases.

All these factors represent the rapid and constant changes that animal industries are experiencing, driven by numerous forces. Those forces, and their possible implications for the future of animal agriculture in North America, are discussed here.

Certain food characteristics, presentations and in-home preparations are important parts of the culture of different groups in the NAFTA region. Such cultural diversity in food is welcome and encouraged within a framework of sound food handling and processing practices that assure food safety.

Consumer Sophistication: Consumers are becoming increasingly sophisticated and are contributing to the evolution of markets for traditional and niche animal products. Consumers are demanding more information and greater access to information

on food safety and animal health issues. These informational needs cut across issues of animal health, antibiotic and hormone use by the industry, production and slaughter practices, and environmental effects of intense and confined production units. Advocacy groups press producers and processors to adopt practices consistent with their demands; this is also reflected in food retailers' pressuring suppliers to adopt practices framed by advocacy groups.

How consumers react to food safety concerns and animal health incidents will shape ongoing industry and government responses and help motivate further innovation and partnering. Responses may involve: 1) market innovations flowing from the private sector; 2) public policies and programs developed to support private initiatives, trading partners or the consumer population; or 3) partnerships and collaborations between public and private interests, primarily in education and improved timeliness and accuracy of information.

The implementation of sound, science-based regulations that include animal welfare and the safety of animal products is needed to avoid subjectivity and provide a legal framework for the different stakeholders in society with interests in the use of animals for the benefit of humans.

Supply Chain Management: Market segmentation, consolidation, integration and concentration in animal agriculture will continue to be key drivers of change. Management of the resulting supply chains enables more rapid and effective responses to consumer demands and government regulations. It is important to recognize that the industry has historically behaved tactically, not strategically and reactively, not proactively. Firms that adapt decision processes and behavior patterns to the rapidly changing marketplace have the potential to reap benefits from increased competitive advantage and enhanced profitability. Process and market innovations driven by technological adoption will characterize successful firms. For example, there is evidence that some of the growth in niche livestock markets may be fueled by consumer concerns and demand for source assurance (see Consumer Demand and Economics Chapters). New models of supply chain management may emerge related to specific food safety/quality attribute certification, in addition to product differentiation and branding.

Costs of Animal Health and Food Safety: Obtaining a competitive advantage is generally cited as a primary determinant of industry or individual firm efforts to arrive at innovative solutions to complex problems. Animal producers and processors are constantly faced with meeting or exceeding regulatory guidelines and market acceptability standards for their products. At the same time, they are adopting cutting-edge technology that is often capital intensive at startup but cost efficient long term. This keeps these operations balancing on the precipice of profitability as they look for ways to cut costs.

Doing business in a global marketplace with exposure to new or emerging pathogens and zoonotic diseases puts a premium on maintaining animal health, preventing disease outbreaks, and dealing with the economic consequences of these management systems, whether successful or not. The economic consequences of widespread and serious animal disease incidents involving avian influenza, foot-and-mouth disease (FMD), Exotic Newcastle Disease (END) or swine fever (cholera) are potentially as devastating as those of BSE. USDA and FDA estimate an outbreak of BSE in the United States could result in a loss of $15 billion in sales revenue and $12 billion in slaughter and disposal (Pritchett et al., 2005). Estimated losses to U.S. farm income from an FMD outbreak are $14 billion (Paarlberg et al., 2002). Even relatively isolated outbreaks, such as the 2002 Virginia END outbreak that affected 197 poultry premises and resulted in approximately 4.7 million birds being depopulated, had a cost of more than $130 million (Bauhan, 2004).

Technological advances to decrease disease losses and changes in management to increase production efficiency will help lower costs for producers. Producers can absorb some of the costs, but eventually, the market will pass some of those costs on to consumers so that producers may remain solvent and competitive.

Pressures facing retailers and distributors are twofold. Increased consumer sophistication results in greater attention to issues such as shelf life, temperature control and overall product quality assurance. Private technology providers are developing tracking capabilities to give retailers and distributors tools to respond effectively to consumer demands. There are competitive pressures to cut costs through provision of shelf-ready meat and poultry products and specialty dairy products priced at the plant production site. Both practices save labor and augment check-out accuracy.

Technological Developments: Impacts of technological developments span the spectrum of animal health and food safety issues. Biotechnology and technology impacts on mitigation of existing food safety incidents and in identification of new food safety concerns through known and emerging epizootic diseases continues to be of paramount importance. Attribution of specific pathogens to foodborne illnesses and other human health events is currently at the epicenter of zoonotic disease tracking. Rapid disease and pathogen identification technology and systems to enable rapid response to animal and human health events or food safety incidents will likely shape the future of animal agriculture.

Globalization: Many international issues relate to implementation of sanitary and phytosanitary restrictions under the World Trade Organization (WTO). Often times these restrictions are imposed as thinly veiled tools of protectionism. It is imperative that North American animal agriculture continues to stay engaged in the difficult business of

establishing food safety system equivalency worldwide despite the existence of freer trade worldwide.

Globalization is not limited to trade and regulatory equivalency. Many diseases thought to have been eradicated have reappeared in both human and animal populations. Exotic diseases may be inadvertently introduced through trading partners. Deterrence and prevention are the first lines of defense against introduction of pests and pathogens from foreign or domestic sources. Strategies involved include global and regional efforts to reduce a potential threat before it reaches the borders, and prohibiting potential threat agents at ports of entry (National Research Council, 2002). Security concerns will continue to drive the need for improved animal disease detection.

Market Innovations: Most innovations originate as private-sector initiatives. Obtaining a competitive advantage is generally the primary motivation for an industry or individual firm to develop innovative solutions to complex problems. Private-sector initiatives fall into three broad categories: 1) source assurance through more aggressive branding of animal products; 2) product technology innovation to support consumer confidence with measurable, scientific criteria; and 3) emerging niche markets that capitalize on uncertainty surrounding safety of the traditional animal product supply chain.

In the commodity food system, consumers have been assured by government agencies that the food is safe and wholesome. Increasingly, consumers want credible sources of additional information on the quality and safety of food and the practices employed in its production. Branding combined with source and process verification may offer increased assurances to consumers. A likely area for innovation in source assurances is information technologies that support tracking systems for food and animal products. Food manufacturers are providing new types of information that are often used to differentiate their brand and that may be interpreted as offering assurances to consumers.

As these systems are introduced at the farm level, some public and private support of small farmers may be necessary to make sure these small farmers adopt these technologies, and thereby avoid risks to the NAFTA food system.

Firms now seek detailed information from suppliers for inbound logistics and procurement for better cost and quality control. Some large national and multinational retail food firms require suppliers to implement tracking systems at both the raw and processed levels. More innovations are occurring that will make traceability of product handling more evident to consumers and partners farther down the supply chain, such as retailers or food services. An example is the negative impact of the total time that products are kept above recommended temperature limits. A German firm has developed an RFID temperature sensor for food products that logs temperature data and can be read with a wireless interface (New Low-cost Temperature Sensor, 2002). Such information can verify handling of a product from processor to purchase. Issues of source and process verification are largely irrelevant for local or regional markets offering animal products with little or no processing.

These private-sector activities illustrate that companies believe their customers (marketing partners) and consumers are seeking additional credible information about how product is produced and handled. This trend is likely to persist, and high levels of private innovation are expected to continue.

In addition to high-profile animal health events like BSE or *E. coli* O157:H7, there are concerns among some consumers on broader public health issues associated with production practices, such as antibiotic and hormone use. Private-sector responses to address these issues are a signal of the market's perception that production assurances will differentiate companies and their brands. A major U.S. pork producer has announced it will limit the amount and kind of antibiotics it uses in pigs to comply with new guidelines imposed by a major customer in the food service industry (McLaughlin, 2005). That firm's decision to buy pork and chicken only from suppliers that do not use growth-promoting antibiotics that come from classes of drugs also used in human medicine is a significant private response to consumer concerns. Most, if not all, livestock and poultry producers limit use of subtherapeutic antibiotics to those not used in humans.

Consumer concerns about the safety of using preventative antibiotics led to the July 2005 decision by FDA to ban Baytril in poultry production. This action comes at a time when an increasing number of companies are marketing "antibiotic-free" meat. However, no meat sold in the United States is allowed to have antibiotic residues that exceed safe levels established by FDA when it enters the human food chain. One firm is capitalizing on the negative opinion toward antibiotic use by releasing a line of broilers that are "antibiotic free" by selective breeding of naturally immune individuals (Pyxis, 2005).

There may be a downside to discontinuing subtherapeutic antibiotics. Following such a move in Denmark, the world's largest pork exporter, overall antibiotic use in animals initially fell by about half, but therapeutic antibiotic use has increased 30 percent to 40 percent (Hayes et al, 2003). Taking away subtherapeutic antibiotics can lead to more frequent need for treatment with therapeutics and the potential for more foodborne pathogens in animals that enter the food chain (Sundberg, 2005).

Better education and more transparent information are needed regarding antibiotic residue issues. Governments may have a role in educating the public on the science behind the debate. This might include clarifying the meaning of "without added antibiotics" and "no subtherapeutic antibiotics."

Efforts at the Production Level to Mitigate Animal Disease and Food Safety Incidents: The trend toward more intensive confined animal agriculture production systems impacts herd and flock disease prevention programs, such as vaccination programs and BMPs, including vigorous biosecurity programs. Practices include vaccinations, sanitation, handling and use of colostrums, separating animals by age and production phases, and restricting all visitors, suppliers and their vehicles. Producers do not want to spend money to change production practices without assurances that such practices will meet the working standards of regulatory agencies and are economically feasible.

Until recently, most vaccination technology was similar to that used in the past century—animals were given whole, weakened, live or killed microorganisms to elicit immune responses. These types of vaccine are still used. Biotechnology advancements during the last five years have increased understanding of disease-causing organisms and pathogenesis of diseases, resulting in safer and more efficacious vaccines.

Advances in biotechnology, gene technology and genomics may allow development of vaccines with genetic sequences that stimulate immunity and/or protect from a number of specific pathogens, parasites and pests. This preventative approach works with the animal's immune system rather than on prophylactic antibiotic use or treatment strategies. Advances such as these may provide immunity solutions in wider disease and production situations, potentially increasing producer profitability.

Risk Assessment and Management: Food animal veterinarians are a vital link in preventing and controlling potential animal health and food safety incidents. The number of food animal veterinary practitioners has declined in recent years. One question is whether there will be adequate numbers of professionals in the field to diagnose, prevent and treat animal diseases in the future. Increased global movement of animal products creates a need for more veterinarians trained in foreign animal disease diagnosis and control, and implementation and enforcement of sanitary and phytosanitary trade standards. Information technology helps to expand training opportunities. In the United States, the recently enacted Veterinary Workforce Expansion Act establishes competitive grant programs to build capacity in veterinary medical education and expand the work force of veterinarians engaged in public health practice and biomedical research. Public health practice includes bioterrorism and emergency preparedness, both of which impact agriculture and the food supply.

The duration, size and extent of quarantines will decrease as animal identification systems are more broadly implemented. Use of satellite mapping for tracking animal movement and more rapid diagnostic techniques, such as DNA probes, to identify disease may help decrease the spread of disease. It has been shown that regional or more limited quarantines can be effective in the control of potential disease outbreaks. More rapid diagnostics and traceability could limit future quarantines to a few or even a single farm. A recent decision by the U.S. commercial chicken industry to voluntarily test for both H5 and H7 avian influenza includes establishment of a control zone two miles around any infected flock. Other flocks within the zone would be held and tested, with testing repeated weekly. The continued testing would ensure that flocks are clear of avian influenza before going to market. Any flock testing positive for avian influenza would be destroyed (National Chicken Council).

Canadian cattle and hog producers have moved quickly to establish animal identification and tracking systems. The federal government has helped industry come together through inter-species organizations to develop standards and protocols for animal identification that can be adapted to all major species. The United States is in the process of developing and implementing a mandatory animal identification and tracking system for animal health protection purposes. This public-private partnership is expected to be in place in 2009.

Emerging and/or re-emerging diseases and pathogens will continue to be a problem in developing nations. This could result in an increase in disease transferability. With agricultural globalization and lessening of trade restrictions, these diseases could become a problem in North America. Educational efforts, disease recognition, more rapid diagnostic testing and prevention programs will be vital to diminish the likelihood of disease spread. Increasingly larger animal production numbers will necessitate affordable insurance instruments for possible problems that could adversely impact the producer. The costs of these programs may need to be shared or covered by government programs.

In Mexico there is no funding to support these studies. Epidemiological surveillance of diseases transmitted from food is still pending. Only large producers commercializing in supermarket chains or foreign markets follow these procedures.

Canada, Mexico and the United States have reached an agreement and have an FMD vaccine bank so that an early response may be reached in a short time. The three countries should build similar capabilities into other animal disease threats.

Efforts to Mitigate Product Contamination in Marketing Channels: There is a need to proactively address preharvest food safety issues. Scientists continue to work with animal producers to investigate production practices that might reduce potential food safety risks. Much is known about the ecology of biological, chemical and physical hazards during animal production; however, specified production practices have yet to be identified to addressing biological hazards that consistently and predictably contribute to improved food safety.

In the United States, FDA, under the Public Health Act, has limited preharvest authority to follow up on human illnesses related to products under its control. USDA's Animal and Plant Health Inspection Service (APHIS) has preharvest authority to address animal disease situations; USDA's Food Safety Inspection Service (FSIS) regulates animal food safety from the point animals enter meat and poultry slaughter establishments through the completion of slaughter and further processing, with limited compliance activities in commerce.

Implementation of producer-level management activities has the potential to reduce the presence of *Salmonella* and other pathogens in animal products. Investigation is needed to: 1) determine if interventions currently available to producers can form the basis for BMPs to reduce *Salmonella* before slaughter; 2) identify promising interventions and determine what steps need to be taken to make interventions to limit and control *Salmonella* available at the production level; and 3) identify research gaps with respect to *Salmonella* control at the production level.

Protecting and Assuring Food Safety: Consumer marketing channels are an information link between producers, retailers and consumers. Consumers may neither be aware of the many options available to familiarize the public with current food safety measures nor have the knowledge of possible outcomes of improper food safety procedures. Figure 1 illustrates consumer attitudes about the seriousness of risks associated with various food safety treatments and contaminants. Figure 2 relates the share of consumers completely or mostly confident in the safety of their food.

Hazard Analysis and Critical Control Point (HACCP) encompasses a set of government regulations that focus on preventative food safety measures. This preventative program helps ensure that unhealthy or unsafe animals and birds never enter the food supply and that safe and wholesome products are sold to consumers. In Canada, the Canadian Food Safety and Quality Program helps industry develop and implement HACCP-based production systems through the food-value chain, as well as train industry in its use. In the United States, FSIS provides information for consumers and processors. Food processors must follow HACCP guidelines and keep written documentation. Food product recalls are monitored and made public, but access to the recall information may be limited for consumers.

The HACCP-based Inspection Models Project (HIMP) is a U.S. project to determine the accomplishments of the current system and develop improvements to the FSIS online slaughter inspection process. Under HIMP, FSIS has established performance standards for food safety and non-food safety defects. Presently, there are 20 young-chicken plants (the maximum permitted), four market-hog plants and two young-turkey plants participating in the study (USDA-FSIS, 2005).

National Association of Slaughterhouses Federal Inspection Type (ANETIF) is a joint effort of the Mexican government and the private sector to implement inspection standards in private slaughterhouses to guarantee the food safety and quality of the meat processed. These facilities process the 35 percent of meat sold to supermarkets or for export. Municipalities have responsibility for slaughterhouses that process meat for traditional Mexican markets. The government also sets sanitary requirements for these operations, but they are not at the level of standards required by ANETIF.

Despite efforts by the Federal Commission for the Protection Against Sanitary Risks (COFEPRIS), Mexico does not have a reliable sanitary inspection in municipal slaughterhouses. This is in sharp contrast with the reliability of sanitary inspections that take place in the 279 private slaughterhouses applying federal regulated sanitary inspection (TIF). There are two sanitary standards—one for exportation and distribution through supermarkets for local consumption, and another for meat purchased at other outlets, largely consumed by people with low economic capacity.

Recalls: Research results indicate that brands suffer when a recall occurs (Thomsen et al., 2006). A sales decline of 22 percent to 27 percent can be expected after a foodborne pathogen recall, with brand recovery taking four to five months. The media play a role in reassuring consumers, but the impact of positive information is considerably smaller than that of negative information (Smith et al., 1988). Current recall procedures address product not meeting regulatory standards or product that has been implicated in human foodborne illness. The current system fails to take a farm-to-table approach to tie all foodborne illnesses to their root cause and then address the root cause. Food companies that implement recall procedures have necessarily determined the root cause for the recall as a food safety concern.

Training and Education: Specific goals should be set to allocate resources effectively and efficiently to prevent human foodborne illnesses. If targeted effectively, increased funding of consumer education may be more effective in preventing foodborne illness. Educational efforts to encourage recycling are a possible model for food safety. Educational efforts for recycling focused on reaching people early in life. Elementary school education turned the nation's children "green," and they influenced their parents to change habits, which led to a measurable increase in recycling—not because they have to do it, but because it was accepted as the right thing to do for the environment. Emphasizing food safety starting at the elementary school level could lead to a population that experiences vastly reduced levels of foodborne illnesses.

Driven by incentives, private industry explores ways to communicate with the end consumer using labeling and media, and to provide the public with products that are largely free

from risk. Food safety experts are continually testing for new strains of foodborne pathogens and providing preventative control measures. Future genetic technology of growing animals with specific disease-resistant traits and non-antibiotic therapies are being tested (Pyxis, 2005). Producers routinely run mock recalls on a random basis to track product to its place of origin. Regional training is being provided by NCBA, where growers are prepared for a future of source and age verification (Wickens, 2005). The Food Emergency Response Network (FERN), which operates 90 U.S. labs, works to prevent and respond to possible attacks and emergencies involving food. Staff at participating FERN laboratories analyze surveillance samples, validate new methods used to detect threat agents in food products and meet guidelines to ensure the security and safety of facilities and employees (Demert, 2005).

In Canada, federal animal health and food safety measures, under the responsibility of the Canadian Food Inspection Agency (CFIA), regulate the health of farm animals and the safety of the products derived from them. To further ensure the unrestricted trade and safety of animal production, CFIA has programs related to animal health and production to guard against the entry of foreign animal diseases and to prevent and control the spread of certain domestic animal diseases. CFIA conducts inspections and has surveillance, monitoring and testing programs in place. In collaboration with provincial departments of agriculture and other agri-food sector stakeholders, Agriculture and Agri-Food Canada (AAFC) and CFIA have jointly established the Food and Agriculture Emergency Response System (FAERS), an emergency management system for natural disasters linking federal, provincial and private sectors to better manage and coordinate response to emergencies. FAERS mobilizes all agri-food sector resources to mitigate the effects of emergencies and to ensure continuity, adequacy and safety of the agri-food system. However, FAERS does not deal with foreign-animal disease introductions.

Innovations: Innovations in the food safety and quality assurance arenas are aggressively pursued by private industry. Funding provided for research and the implementation of new technology and safety practices give industry leaders an advantage in providing a safe food environment for consumers. For example, Pyxis Genomics has proposed implementing the first integrated traceability platform for pork (Pyxis, 2005). TEMPTIME™ Corp. manufactures time temperature indicators which are self-adhesive labels the retailer can apply to perishable food packages (TEMPTIME, 2005).

Mexico has good infrastructure and human resources, but not enough to perform quality research in animal health issues in government research institutions and universities, most of which are supported by the government.

With passage of the Sustainable Rural Development Law in 2001 and the Science and Technology Law in 2002, Mexico has legal support to coordinate and encourage research, but there are insufficient budgetary resource to fully support these demands.

An important strategic issue with potential to benefit Canada, Mexico and the United States would be to formalize a cooperative research and training program on animal health issues of common interest.

Summary

Protecting the safety of the food supply is essential to all countries, and Canada, Mexico and the United States spend significant resources to assure that it is safe and wholesome. While consumers do not always understand the science behind industry practices and government policies, North American consumers have a high degree of confidence in the safety of their food. Technological developments to enhance production efficiency and/or protect animal health often raise concerns among consumers in spite of the rigorous product approval process and ongoing testing and surveillance programs. Globalization of food trade provides greater food choices, and potentially confusion, if there are not consistent standards for safety and labeling. Increased consumer sophistication and advanced information technology pose both a challenge and an opportunity for firms and the government to inform consumers and address their concerns. Advanced supply chain management systems allow for tracing food products that result in faster, more targeted recalls when needed. Private-sector efforts to minimize risks of recalls and protect brand equity are part of an effective food safety strategy.

Animal health is closely linked to food safety and consumer confidence and is also central to the profitability of the livestock and poultry production sectors. Increased production costs, lower revenues for farms with a disease and trade restrictions due to the presence of particular diseases have economic impacts on all producers in the industry. For example, one cow testing positive for BSE in the United States resulted in the immediate loss of $4.8 billion in annual beef exports (Doud, 2006). To protect animal industries and consumers from imported diseases or food safety problems, sanitary and phytosanitary standards have become part of most trade agreements. However, these standards can also be trade distorting and protectionist and accentuate the need for harmonization of standards and enforcement within NAFTA.

The North American live animal market is increasingly linked and companies within countries are evermore interdependent. Once implemented across North America, animal identification and tracking systems could allow restricted animal movement within or across countries while still controlling the disease. Farm-level biosecurity measures to reduce disease risk and developments in vaccine research are providing new tools to lessen the threat and impact of animal diseases to farmers.

Policy Options and Implications

Animal health and food safety are for the public good and important elements of national security in all North American countries. The challenge is to develop and implement policies that most effectively achieve a safe and secure food supply and a competitive livestock and poultry sector in North America. The options discussed below offer a range of public-sector involvement and discretion on how to utilize scarce government resources.

Public Programs and Policies

Recent BSE cases in the United States and Canada have crystallized concerns that consumers, livestock producers and allied industries share about the economic impacts of animal disease and the complexity of estimating the size of such impacts. Public agencies have responded with resources and more visible programs to guard against potential outbreaks and maintaining consumer confidence.

Policy instruments to share losses, policy costs and program benefits might be used to guard against losses at each level of the animal industry. To be effective, public policies and programs to manage the risk from animal health outbreaks will need to be well-designed and consider private incentives as different types of livestock producers will respond differently (Pritchett et al., 2005). Government intervention may prove necessary because market failures and public goods (such as public health) may not provide adequate private incentives to achieve efficient protection against animal health threats.

Accelerated response times to adverse food safety and animal health incidents are needed. This is especially crucial when timely responses can limit the spread of disease, or when there may be distribution or sale of infected or contaminated livestock products. Consumers and businesses expect government to quickly and effectively investigate and communicate a potential event. While the United States and Canada have reasonably well-functioning systems, epidemiological surveillance of diseases transmitted from food is still pending in Mexico, primarily due to lack of funding. The potential economic impact of an incident is a function of the time between the announcement of the potential event and the confirmation of its validity.

Public and Private Partnerships

Adding credible certification and labeling processes proposed by industry and improving coordination of animal health and food safety responses are ways governments might proactively partner with private industry. Funding research and developing programs to build scientific, educational and managerial capacity to respond to or prevent animal health and food safety incidents are other possible government actions. Consumers may perceive that the government is addressing their needs by providing third-party verification of credence attributes promoted by private brands and firms. For example, the Mexican government has cooperated with the private sector to implement Mexico Calidad Suprema (Mexico Supreme Quality), an officially supported label which is intended to assure that Mexican food products are safe and of superior quality. This standard has not been fully achieved to date.

In Canada, Mexico and the United States, government investments are made in research addressing veterinary science, food science, epidemiology and economics of animal health and food safety issues. Some argue that development and implementation of research findings has slowed progress in addressing issues. Under this option, government would support more research on technology and science to maintain a safe food supply, leaving the private sector to concentrate on investments in quality assurance.

Up to 90 percent of all foodborne illnesses are attributed to handling and preparation, often in the household (Schutze et al., 1999). The public sector might increase consumer outreach, augmenting private efforts. Programming could be similar to and, possibly in cooperation with, nutrition education programs already provided by public institutions, such as the USDA's Cooperative State Research, Education and Extension Service. Created by the National Restaurant Association Education Fund, the ServSafe program certifies food service managers in food safety and provides resources to help maintain sound food safety practices by workers in the food service industry. This program could be strengthened and redirected.

Because of its reputation for being impartial and science-based, the U.S. Land Grant university system could in its cooperative relationship with USDA play an expanded role in providing educational programs on the food system, animal health and food safety and in providing research to undergird food safety programs at the regional, state and local levels. Additional research funding may be needed. Comparable relationships do not exist in Canada and exist to a much lesser degree in Mexico.

While public-private partnerships have the potential to generate many benefits, care is needed. There is an inherent conflict in governments' dual roles as advocate and regulator. To maintain public confidence in the food safety system, separation is needed between the rule makers, enforcers and educators. Universities and government agencies must maintain strict independence in funding and conducting research, outreach and regulatory functions. This will assure an increasingly well-informed public that these institutions provide credible and well-founded information.

Coordination of Public Efforts

In the United States, the national structure of the food safety system is expected to continue moving toward a single food safety system functionally, even if not through legislative changes to create a single food agency. Coordination of food safety efforts by government agencies will likely expand to identify the cause of food-related illnesses through source tracking and attribution to known and unknown pathogens. New methods would allow food safety officials to pinpoint the reasons for breakdowns in the food safety continuum and target more specific preventive measures. Efforts focused on identifying interventions at processing plants could be expanded to include other components of the food supply chain. Funding national programs to train and educate producers on food safety production practices would increase the quality of end products and marketability for the producer.

Due to low educational levels of some traditional Mexican farmers, it may be necessary to use a variety of media to reach this audience with information on how to use certain animal pharmaceutical products to avoid food safety risks.

Consideration should be given to developing a risk-based pathogen analysis system that would identify existing epizootic links from animals to humans, particularly in the face of looming outbreaks, such as the current situation involving avian influenza. Efforts to combat foodborne illness are focused on easily identifiable hazards, although the cause of the majority of foodborne illness is never determined; estimates of the actual causes of foodborne illnesses gathered in the Morbidity and Mortality Weekly Report (MMWR) of the U.S. Center for Disease Control (CDC) are based on information from eight "representative" states (Figure 3). For known pathogens, the ability to identify the common source of foodborne illnesses, even for geographically dispersed human cases, is expanding because of technological advances in genetic. During the next five to 10 years, the increasing ability to identify risky products and remove them from market channels will help reduce foodborne illnesses from known pathogens.

Despite research indicating the need for more effective consumer education, implementation of successful food safety education programs is limited. Consumer education needs will increase. Identification of the balance between what consumers think they want and need with a more scientifically based understanding of what the public health community recommends would be helpful.

Researchers are developing and adapting new technologies to address food safety issues. One result may be a system to assist regulatory and industry personnel in attaining compliance, optimizing efficiency and providing a safe product. Future research is expected to help automate inspection of poultry carcasses and implement these machines at on-line slaughter facilities. These on-line machines use a real-time visual detection system that can be incorporated into an HACCP plan for detection of external/internal damage and fecal contamination. Under development are spectral and image detection and in-house multispectral and laser-induced fluorescence imaging systems for real-time detection of diseases, defects and contamination on poultry carcasses. Also being developed are optimal spectral preprocessing treatments for imaging contaminated meat that identifies the site and type of contamination (MMWR, 2005). These technological tools would increase the safety of livestock food products.

The Codex Alimentarius Commission is an international organization that promotes fair trade while considering the global economic and personal health of the consumer. More than 160 member countries have access to its standards, codes of practice and guidelines for use in trade. Codex forums will continue to set standards to facilitate international trade of food products and provide information on innovative food safety systems, new technology and trade practices. Sharing this information may lead to safer food supplies.

The World Organization for Animal Health (OIE) has international guidelines to regain disease-free status for a country affected by animal diseases. Even once disease-free status is regained under OIE rules, recovery of each export market has to be renegotiated by the exporting country. OIE guidelines are voluntary and usually interpreted as minimum requirements from importing countries to open borders to exports. Importing countries may ask that additional measures be taken to prove that exported products are free from any trace of the disease. There are, however, current OIE efforts to redirect trade rules under an animal disease context toward a more risk-oriented approach. This could result in improved food safety and more efficient trade.

A Comprehensive NAFTA-wide Diagnostic, Monitoring and Surveillance Network

Food safety and animal health threats go beyond the ability of a single entity to affect the entire animal production value chain and even the economy as a whole under the right circumstances. A cooperative and functional NAFTA-wide network would multiply the efficacy of networks in the United States and Canada and establish a comparable functioning network in Mexico. The network could include stockpiles of vaccines and treatment agents for many diseases and serve as a clearinghouse for effective quarantine and animal disposal protocols to limit disease spread. Precedence for creating such a cooperative effort include the FMD and the screw worm eradication programs established jointly between Mexico and the United States. Those programs effectively ended the extensive and adverse impacts of these two animal health issues in North America.

A national structure coordinated by governments within NAFTA countries could serve as a focal point for engaging and enhancing partnerships among government agencies and the private sector (National Research Council, 2005). For example, in the United States, several federal and state agencies and various animal and human health organization programs are responsible for food safety and animal health policy, but there are implementation gaps, ineffective communications and lack of information sharing.

Enhance Capabilities for Rapid and Widespread Information Dissemination

Both government and the industry would benefit from fast and widespread access and dissemination of information when dealing with food safety and animal health hazards. This information is essential to retain consumer confidence in the food systems at home and abroad. Establishment of national tracing systems would be important. Increased public and private investment could help reduce disease transmission and enhance public and animal health. Increased public awareness through education and training programs is critical to food safety and animal disease prevention. It may be possible to develop tools focused on strategic and tactical cooperation between the public and private sectors in the event of food safety, animal health or biosecurity emergencies.

Support New Scientific Tools and Technologies

New scientific tools and technologies are being developed that have the potential to enhance animal disease prevention, detection and diagnosis in North America. Work is needed in current animal health frameworks to evaluate, validate and implement rapid prevention strategies to protect the health of each nation's animal populations. One area of concern is strengthening border protection systems regarding the importation or unnoticed transfer of animals raised out of the mainstream food security network. Exotic animals, backyard poultry and backyard livestock have the potential to place national herds and flocks at risk.

Veterinarians play a key role in any animal disease prevention, detection and diagnosis in North America. To strengthen long-term availability of this human capital, governments could develop programs that involve more private-practice food-animal veterinarians and devote more resources to public health and research veterinarians. In the United States, there are concerns about a potential shortage of research veterinarians. A National Academy of Sciences National Research Council report states stronger efforts are needed to recruit more veterinarians and other scientists into veterinary research, noting that a growing shortage of veterinary pathologists, lab animal scientists and other veterinary researchers is making it more difficult to meet mounting challenges (National Research Council, 2005).

Establish Indemnity Insurance for Animal Agriculture

In the United States, there are currently no uniform government-backed insurance programs for animal agriculture that parallel those for crop agriculture. Consequently, livestock producers may absorb catastrophic losses (destroyed animals, market loss, business interruptions) that may be associated with animal health events unless the disease is determined to constitute a national emergency, in which case producers would be indemnified 100 percent. Financial risk management of animal diseases is a question that government and industry must address in partnership to ensure that effective and efficient financial risk management tools are in place to deal with future animal disease outbreaks. An indemnity program could reduce private-sector uncertainty and thus increase reporting compliances. Participation in such a program would be predicated on following strict biosecurity protocols related to level of risk. A broader production certification program addressing food safety, animal health and emergency management could also be developed.

International Food Safety and Animal Health Standards for Trade

The lack of consistency in international standards and their enforcement creates inequities in trade among potential partners and may well limit trading arrangements. Eliminating this artificial trade barrier would allow competitiveness to be more accurately evaluated; gains from trade may be more fully realized. There are currently prescribed events and standards that signal conditions for which trade interruptions commence, but such signals to recommence trade are not readily apparent. Establishing "triggers" that allow trade to resume once food safety and animal health concerns were alleviated could contribute to freer trade within NAFTA, as could true harmonization of standards and enforcement among NAFTA partners.

Knowledge Gaps and Research Needs

As the risks to animal health evolve, so must mechanisms to address them. To develop and implement effective and efficient tools, work is needed to assess and predict this evolution of risks, evaluate the current system's response capabilities, identify areas where improvements may be warranted and communicate them effectively.

- Research is needed on risk-management tools that livestock producers could use to mitigate catastrophic financial losses from destroyed animals, market losses or business interruptions related to animal disease outbreaks. What tools might be developed in the public and private sectors? Would an indemnity program reduce private-sector uncertainty and thus increase reporting compliances?

What would be the most effective way to structure an indemnity program?

- Research is needed on scientific, managerial and educational tools and practices to enhance identification of and response to an animal disease outbreak. Continuing research is needed on technological tools that can identify diseases, defects or contamination in animal products. How to effectively provide consumers with information on issues related to animal disease outbreaks is another area where additional research is needed.
- What mechanisms need to be explored for establishing "triggers" that allow cross-border trade to resume once food safety and animal health concerns are alleviated? What process can be identified to move the NAFTA partners toward harmonization of food safety and animal health standards and enforcement?

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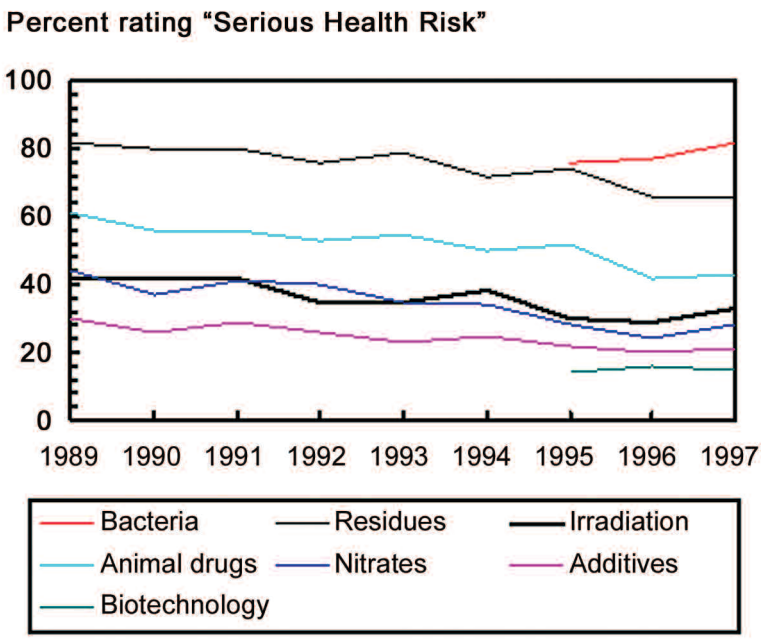
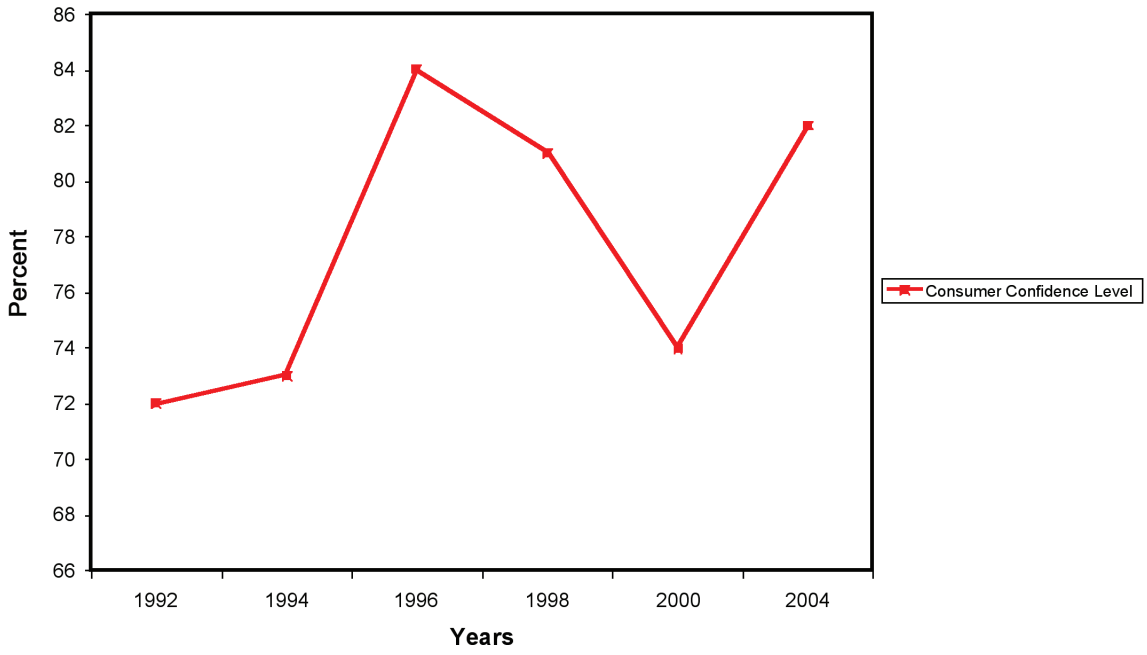
Figure 1. **Consumer Attitudes About Risks in Food**



Source: "Trends in the United States: Consumer Attitudes and the Supermarket," Food Marketing Institute, 1989-97.

Figure 2. **Overall Confidence in Food Safety**



Source: Trends in the United States: Consumer Attitudes and the Supermarket, Food Marketing Institute, various issues

Figure 3. **2004-05 Reported Cases of Notifiable Diseases in the United States**

Pathogen	2004	2005
Campylobacter	12.9	9
E. coli O157:H7	2,452	2,368
Listeria	710	769
Salmonella	40,263	40,327
Shigella	13,327	13,195
vCJD	0	0

Source: U.S. Center for Disease Control