Canadian Research Institute for Food Safety
Institut canadien de recherché sur la sécurité des aliments

Improving Food Safety Through Research

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The Canadian Research Institute for Food Safety is a multidisciplinary research organization. We are committed to working with all stakeholders in the agri-food system to be a leading national and international centre for the generation, analysis and communication of sound scientific information that enables the economic production of safe, nutritious and affordable food.

An Introduction to CRIFS—Improving Food Safety Through Research

The Canadian Institute for Food Safety is a unique Canadian organization capable of studying all aspects of microbial food safety from production to processing and consumption, as well as having expertise in risk assessment, policy evaluation and toxicology research. CRIFS has an internationally recognized group of scientists, a dedicated microbiological research facility and the latest in processing and analytical equipment.

The CRIFS initiative is housed in the newly renovated laboratory complex on the campus of the University of Guelph. The facility was officially opened in September 2002. In this report you will be informed of some of the projects that scientists within the CRIFS organization are conducting or have completed and we believe you will be impressed by the scope and significance of the work.

CRIFS has strong working relationships with and support from key players in the agriculture and food industry, including Agriculture and Agri Food Canada, Health Canada, the Ontario Ministry of Agriculture and Food and industry organizations. This allows CRIFS to act as a facilitator for industry/ government/academia partnerships focusing on improving food safety.

CRIFS Services

CRIFS provides services in the following areas:

1. Research. CRIFS has a multidisciplinary team of over 50 researchers capable of addressing all aspects of microbial food safety, including risk assessment, from farm to fork. Contractual and collaborative research are both welcomed. Access to the latest in processing and analytical equipment enables CRIFS scientists to tackle food safety problems at all stages of the food supply chain. Specific areas and examples of research are detailed later in this brochure.

2. Policy. CRIFS has a Food Policy group that focuses on bridging the gaps between science, society and policy. This group is skilled in both evaluation and communication.

3. Information. CRIFS has experience in the dissemination of information on key food safety issues and research results, through timely publications, electronic bulletins, alerts and regular meetings organized by CRIFS. The Food Safety Network provides a free daily bulletin of food safety news to thousands of individuals.

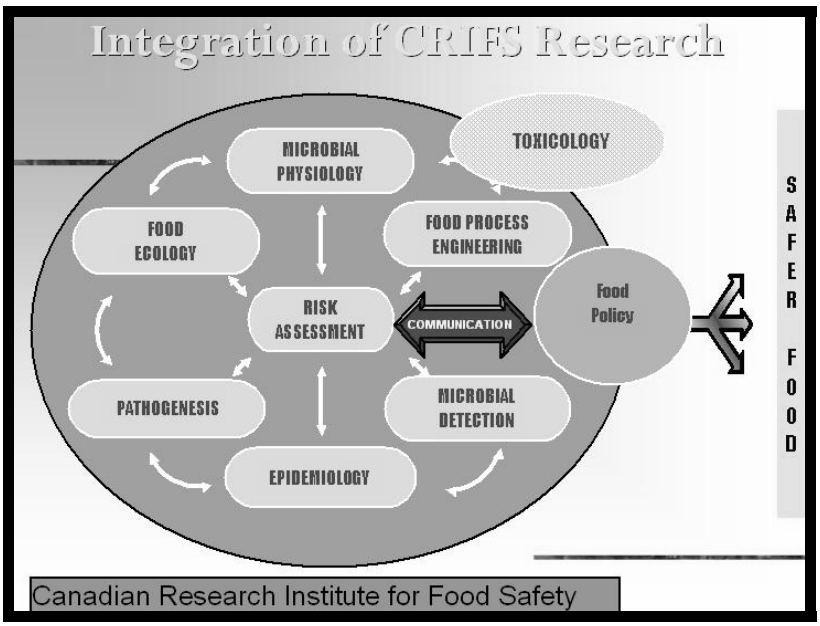
4. Consultation. Trouble-shooting services in the field are provided by CRIFS members to industry, government and consumers on food safety, regulatory and trade issues.

5. Food Safety Training. CRIFS personnel provide training in regular workshops for industry personnel. Graduate student and post-doctoral fellowship training are also major focuses.

A Brief History

CRIFS was born out of a vision for success through the collaborative research culture at the University of Guelph. A group of researchers formed the Guelph Group for Research in Food Safety which became CRIFS. In September 2002, thanks to the generous support of the Canada Foundation for Innovation and the Ontario Innovation Trust, CRIFS opened the doors of a newly purchased and renovated building on the University of Guelph campus, complete with the latest in molecular biological and imaging instrumentation. The building has Level II biocontainment designation currently, and is working towards Level III.

Areas of Expertise and Achievements



CRIFS scientists are internationally recognized for their research on *E.coli,* including *E.coli* O157:H7*, Salmonella* and *Campylobacter* and antibiotic resistance. They are also leaders in the application of rapid detection techniques to food safety and in the development of risk analysis programs in microbiological and toxicological aspects of food safety. A number of the CRIFS projects noted below have been supported by industry partners such as Sara Lee, Poultry Industry Council, Institute Rosell Inc., Ontario Pork, Dairy Farmers of Ontario, Beef Cattle Research Council, Alberta Sheep and Wool Commission, Elanco, Pride Pak, Biosys Inc., Can-Oat Milling Products Inc., Canadian Poultry and Egg Processors Council and Ontario Greenhouse Vegetable Growers Association.

Food Ecology

The microbiologists in the Food Ecology group focus on devising more effective ways to eliminate disease-causing microorganisms from food by examining the interactions between the pathogens and food production and processing environments.

- A research project was completed to determine how the composition of apple cider influences the ability of *E.coli* O157:H7 to survive pasteurization. This identified the best pasteurization temperature to maintain good taste and ensure a safe finished product.

- A project on mayonnaise was undertaken to predict the survival rate of *E.coli* O157:H7 in mayonnaise. With this information, the required acidic conditions for the production of a safe mayonnaise were determined.

- Probiotics were used in a recent research project to manipulate poultry microflora to prevent the spread of *Salmonella* and *Campylobacter* in poultry populations.

- A research project on dry fermented sausages is underway to develop a better way to formulate the sausages to reduce the survival of pathogenic *E.coli* O157:H7 in them.

Epidemiology

The researchers in the Epidemiology group study the links between specific food production and processing practices and human health outcomes. By understanding these patterns, antimicrobial resistance can be reduced, and more effective ways found to eliminate the spread of disease through food and water.

- A major thrust of work has been to determine antimicrobial resistance in numerous environments, such as farmed trout, feed mills and sheep, in order to determine the risk of transfer of microbial resistance through food production practices. The result is the development of new strategies for the safe use of antimicrobials in food production.

- Ontario cull dairy cows entering the food system as beef are currently being studied to determine the incidence of antimicrobial resistant E. coli and Salmonella species. The results will inform the industry in the development of dairy specific clinical drug use guidelines and on-farm quality assurance protocols to prevent resistance development.

- A study on pork production practices is evaluating the efficacy of current practices operated in different slaughter lines to prevent the spread of enteric contamination on carcasses. This research is providing recommendations on the best strategies for the control of Salmonella in pig processing.

Microbial Detection and Characterization

The researchers in the Microbial Detection and Characterization group focus on improving testing methods for pathogens. Rapid, easy-to-use and economical tests for the detection, identification and counting of pathogens and spoilage organisms are essential tools for the food industry and for public health. Their work enables more rapid identification and investigation of outbreaks and transmission of pathogens in the food chain.

- One research study assessed the applicability of new detection systems for *Listeria monocytogenes,* in order to find a system that was more rapid and cost effective than those presently in use. This is particularly important as the United States Department of Agriculture is contemplating new regulations that would require product testing for *Listeria*.

- A project to develop methods to rapidly detect genetically engineered crop varieties is underway. This will allow quick verification of packaging label claims on foods.

- Disease outbreaks are caused every year by imported raspberries. One group of CRIFS researchers found a method to quickly identify contaminated fruits, significantly reducing the likelihood that infected fruits will reach store shelves.

- CRIFS researchers evaluated methods to determine the sources of fecal pollution in water – human, livestock or wildlife. Their research resulted in finding the fastest and most effective ways to identify sources and hence to respond to water contamination problems.

Pathogenesis of Foodborne Microorganisms

The researchers in the Pathogenesis section have expertise in determining how foodborne pathogens cause human illness. By identifying the ways by which organisms can cause human illness, it becomes possible to develop strategies for treatment and prevention.

- A research initiative by this group is the use of genomic approaches to understand the virulence of *E.coli* O157:H7, the microorganism responsible for the Walkerton water tragedy in 2002. By gaining insight into the mechanisms for the shedding of *E.coli*, it becomes possible to develop ways to prevent its movement into water supplies.

- Another CRIFS project underway is the testing of bacteriophages (viruses which target and kill specific bacteria) to prevent the contamination of products such as alfalfa sprouts, poultry and cheese with food-borne pathogens that can cause human illness.

- CRIFS researchers developed a rapid, simple and inexpensive enzyme immunoassay system for simultaneous detection of multiple allergens in foods. This assay is especially useful as a primary screening tool to rapidly identify food allergens in a food sample.

Food Process Engineering

Engineering principles help the Food Process Engineering group study the effects of new processing, packaging and preservation techniques on microorganisms and food product characteristics in order to improve disease prevention while maintaining food nutrition and taste. Areas of specialty are thermal and non-thermal pasteurization and sterilization methods.

- A project is underway to prevent bacteria from entering and colonizing the cut surfaces of fresh produce such as lettuce, utilizing a special wash treatment. This will help improve their safety and shelf life.

- Human pathogens can become internalized in sprout seeds and cause illness. One CRIFS research project developed a new more effective treatment to decontaminate seeds and thereby ensure safe sprout production.

- The effect of using a bacterial inoculant to eliminate *E. coli* O157:H7 from barley silage was assessed. The silage inoculant was effective and the research results are important to ensure best practices in creating safe silage.

- A natural antimicrobial product is being tested for its efficacy in killing bacteria in delicatessen meats. If effective, the natural product may be incorporated into packaging materials.

- A technique for the non-thermal processing of milk, high voltage electrical pulses (HVEP) is being tested. This technique is of particular interest in soft cheese production, where pasteurization has a negative affect on taste and texture. Processors could use the HVEP method to kill bacteria more effectively and at the same time retain quality.

Microbial Physiology

The Microbial Physiology group gains knowledge of the molecular responses of microbial cells to their environment. By finding out how microorganisms survive in different environments, it is possible to find better ways of stressing and killing them.

- CRIFS researchers have recently investigated food-borne pathogen resistance to disinfectants. They found that *Listeria monocytogenes* could acquire resistance to sanitizers commonly used in food processing. The group's research has led to findings that will lead to new control strategies for this food-borne pathogen that can cause abortions and death in susceptible people.

- A research project is underway to develop a model to predict the behaviour of the foodborne microorganism *Listeria monocytogenes* . By predicting the length of the adaptation period of the microorganism, the period before its rapid growth, it becomes possible to develop processes to extend shelf life in food products.

Microbial Risk Assessment

The Microbial Risk Assessment group develops models that promote the understanding of a system (eg. a farm-to-fork food production system, a food processing system, a system describing an infection process) so as to identify accurate risk reduction options for that system. This comprehensive and scientific approach is effective in targeting those foods, food manufacturing processes and food handling processes that pose the greatest risks to society. From a broader perspective, by quantifying risk, food safety authorities will be better prepared to prioritize efforts and resources to reduce or eliminate high impact risks.

- A probabilistic analysis for the growth of *Clostridium perfringens* during foodservice operations was completed using surveys and on-site food safety assessments. This analysis pinpointed the processes within the preparation and serving steps that are most key to reducing the risk of *C. perfringens* growth on foods. The food services industry will use these results to adjust their practices where necessary to ensure the safe handling of food.

- An evaluation was completed to assess recommendations provided to consumers regarding the safe preparation of foods, such as turkey, in their kitchens. The findings indicated the need for more clear, consistent and evidence-based messages to consumers in order to ensure safe food preparation in the kitchen.

Food Policy

The Food Policy group concentrates its work on bridging the gaps between science, society and policy for food safety issues. The results of their research helps to answer the question of how best to compel individual producers, retail employees, and consumers, to adopt best practices to reduce the risk of foodborne illness.

- A research project is underway to assess the impacts of global climate change on the incidence of waterborne diseases in Canada. The research project is investigating the incidence of waterborne illness in Canada, describing the inter-relationships between disease incidence, weather parameters and water quality/quantity, and projecting the potential impact of global climate change on these relationships. This work will identify Canadian regions, watersheds and communities at increased risk of waterborne disease due to climate changes. This information will enable Canadian policy makers to implement adaptive strategies to better protect Canadians from waterborne diseases.

- Consumer attitudes of agricultural biotechnology were evaluated in a recent research project. This information has been used to develop communication tools to better convey the issues to consumers in order to increase public confidence in the technology.

- An on-farm food safety program for the production of fresh produce was developed and implemented with the help of CRIFS researchers. Through the use of microbiological testing, on-site visits, and producer surveys, it was determined that the program has increased grower awareness of microbial risks associated with fresh produce and caused improvements in practices used within greenhouses and packing sheds.

Toxicology

The toxicology group researches methods for predicting the bioavailability of metals in food. By understanding the true exposure to metals in our food, relative risks can be assigned to foods that are being consumed. Strategies can then be developed to reduce the risk of consuming metals in food. In addition, site specific soil risk assessments can be completed and risk mitigation plans implemented.

- CRIFS researchers are developing a novel method for estimating bioavailable cadmium in foods. This research is focusing on detecting the cadmium that actually crosses the intestinal wall versus what is ingested and later excreted. The information will be used to determine safe levels of food consumption for consumers. The methodology can likely be utilized for other metals.

Research Facility and Equipment

The CRIFS building at the University of Guelph offers a sophisticated, fully equipped microbiological research facility for molecular typing, genetic analysis and imaging. CRIFS has equipment and technical capabilities to perform a variety of research and diagnostic tests including cell sorting, tissue culture, cellular imaging, DNA preparation and analysis, molecular fingerprinting and radioisotope work. CRIFS is currently working towards obtaining a Level III biocontainment designation. This will provide CRIFS researchers with the opportunity to work in the facility with Risk Group III pathogens responsible for foodborne diseases and zoonoses, in a safe and secure environment. This includes pathogens such as West Nile virus, BSE (bovine spongiform encephalopathy) and tuberculosis.

CRIFS has also invested in modern food processing equipment to create a lab for the study of the influence of processing on food-borne pathogens. The majority of the food process engineering research will be conducted at this facility. In addition, equipment for food toxicology work is available on the University of Guelph campus.

1. Major Molecular Typing and Gene Analysis Equipment

a. Molecular Biology. For molecular epidemiology research, CRIFS is equipped with a riboprinter and pulsed field gel electrophoresis (PFGE) technology. Using powerful genetic fingerprinting information, the RiboPrinter® system can provide an automated genetic snapshot of any bacterium isolates including spoilage organisms and foodborne pathogens. PFGE is another method used to generate genetic fingerprints from known bacterial cultures, which is based on the separation of large fragments of genomic DNA. Resulting fingerprints can be analyzed visually or by using gel documentation software to determine the genetic relationship among bacterial isolates.

b. Imaging Equipment. The principal imaging equipment used at CRIFS are the flow cytometer and the confocal laser scanning microscope. The flow cytometer is a high-performance instrument that can rapidly detect and sort cells on the basis of their size, surface structure and phenotype. Cell types of interest can be aseptically sorted from complex mixtures and recovered alive for use in future experiments. Confocal microscopy can produce three-dimensial images of unrivaled structural detail.. It is essentially a non-invasive and non-destructive technique and can be performed even on living cells. Other imaging equipment is also on hand.

c Genomics. CRIFS has a DNA preparation room and specialized equipment for sequence detection and identification. The electroporation equipment is used for cloning applications or to introduce gene expression reporters into bacterial or other types of cells. Polymerase chain reaction (PCR) technology is used to target and exponentially replicate specific bacterial genes (i.e. virulence genes). CRIFS' most advanced and flexible real-time PCR system is designed for automated high-throughput detection of fluorescent PCR-related chemistries. PCR has wide application in pathogen detection and identification. CRIFS has several temperature cyclers that greatly facilitate the optimization of PCR experiments in terms of both speed and flexibility.

d CRIFS has microbiology media preparation capabilities as well as incubator room, environmental chambers, automated platers and microtitre plate readers.

2. **Major Food Processing Equipment**

The food processing facility focuses on developing, adapting and modifying non-thermal pasteurization and sterilization methods for the treatment of food products.

a. High pressure processing (HPP), subjects liquid and solid foods, with or without packaging, to pressures between 100 and 800 Mpa. High pressure processing can be used to inactivate pathogenic microorganisms with minimal heat treatment.
b. Ultraviolet processing involves the use of radiation from the ultraviolet region of the electromagnetic spectrum. The germicidal properties of UV irradiation are due to DNA mutations induced by DNA absorption of the UV light.
c. High intensity pulsed electric field (PEF) processing involves the application of pulses of high voltage to foods placed between 2 electrodes. It can inactivate microorganisms and enzymes with only a small increase in temperature.
d. Power ultrasound, higher power ultrasound at lower frequencies (20 to 200 kHz), has the ability to cause cavitation (micro-mechanical shocks that disrupt cellular structural and functional components up to the point of cell lysis). This has uses in food processing to inactivate microbes.
e. Radio frequency heating is currently being investigated as an alternative to conventional high-temperature-short-time pasteurization. It consists of heat being generated by the application of an alternating electric field.
f. The heat exchanger processing unit is designed to allow small samples of liquid food to be processed in the laboratory. It mirrors the industrial processes of HTST and UHT treatment that are used to give increased shelf life to products.
g. Ozone is used as an anti-microbial agent for food treatment, storage and processing. When ozone is used to destroy harmful microorganisms on food, it leaves only oxygen as a byproduct. It leaves no taste, odor, or flavor and unlike chlorine, no residue.

3 **Major Toxicology Equipment**

a. The ICPOES (inductively coupled plasma optical emissions spectrometer) system measures the concentrations of multiple metal elements in a sample at the same time. This technology requires smaller numbers of samples and is faster than single element detection methods.

F. Interfaces within the University of Guelph

CRIFS' connection with the University of Guelph provides it with access to other university entities that also play key roles in food safety. These facilities expand the research capabilities available through CRIFS. Among the most important links are:

1. Laboratory Services. The University's Laboratory Services provides analytical, research and regulatory testing and consultative services in support of agriculture and food excellence. They offer a comprehensive laboratory diagnostic and consultation service for both food producing and companion animals, including a disease surveillance program for food-producing animals. More than 815,000 tests were performed in support of food safety programs in 2003.
2. Food Safety Network. The Food Safety Network at the University of Guelph provides research, commentary, policy evaluation and public information on food safety issues from farm-to-fork. Using electronic networks, extensive databases and rigorous field research, the Food Safety Network works closely with CRIFS as well as national and international collaborators to put science into action -- to develop and implement scientific and publicly credible policies and programs to enhance the safety of the food supply.
3. Guelph Food Technology Centre. The GFTC is an organization which helps food companies and food entrepreneurs improve their competitiveness and profitability by helping them develop new products, design processes, train their staff, and implement safety and quality systems such as HACCP (hazard analysis and critical control point) in their facilities. The technical services that GFTC provides include product and process development, shelf life, packaging, nutrition labelling, sensory evaluation and training, equipment evaluation and auditing and certification for food safety and quality systems.

G. Call for Input – What can CRIFS do for you?

Outbreaks of foodborne illness have caused consumer and industry awareness about food safety to heighten to levels never seen before in Canada. The Canadian Research Institute for Food Safety, CRIFS, is fully equipped to work on emerging food safety issues in the agriculture and food industry. We have designed this brochure, as part of our communication process to make sure the industry is aware of CRIFS resources, capabilities and expertise.

Now that you have read about CRIFS expertise and capabilities, we would like you to **tell us how we can help you**. We invite you to discuss your food safety needs with us. We believe that CRIFS will be a valuable partner for any organization that is concerned about food safety.

Here is how we can be reached:

Canadian Research Institute for Food Safety
University of Guelph
43 McGilvray Street
Guelph, Ontario
Canada, N1G 2W1
Fax: 519-763-0952
E-mail: crifs@uoguelph.ca
Tel: 519-824-4120
http://www.uoguelph.ca/OAC/CRIFS/

Director: Mansel W. Griffiths, B.Sc., Ph.D.
Ext. 52269
mgriffit@uoguelph.ca

Administrative Coordinator: Maria V. Case
Ext. 58010
mcase@uoguelph.ca

Business Manager: Peggy LeSueur, P.Ag.
Ext. 53305
plesueur@uoguelph.ca

O. Brian Allen, Professor, Department of Mathematics and Statistics, University of Guelph * Shai Barbut, Department of Animal and Poultry Science, University of Guelph * Burton Blais, Technology Department and Transfer Unit, Canadian Food Inspection Agency * Ann Blake, Technical Operations Manager, Canadian Research Institute for Food Safety * Patrick Boerlin, University of Guelph *Luba Brovko, Department of Food Science, University of Guelph * Maria Case, Administrative Coordinator, Canadian Research Institute for Food Safety * James R. Chambers, Food Research Program—Molecular and Cellular Biology, Agriculture and Agri-Food Canada * Shu Chen, Analytical Services Unit, Laboratory Services Division, University of Guelph * Valerie J. Davidson, School of Engineering, University of Guelph * Anne E. Deckert, Veterinary Epidemiologist, Laboratory for Foodborne Zoonoses, Health Canada * Jeffrey M. Farber, Bureau of Microbial Hazards, Health Canada * Christine M. Forsberg, Laboratory for Foodborne Zoonoses, Health Canada * Henryk Fuks, Department of Mathematics, Brock University * Joshua (Jianhua) Gong, Food Research Program—Molecular and Cellular Biology, Agriculture and Agri-Food Canada * Sophie Gouveia, Food Research Program—Molecular and Cellular Biology, Agriculture and Agri-Food Canada * Mansel W. Griffiths, CRIFS/University of Guelph * Carlton L. Gyles, Department Pathobiology, University of Guelph * Beverly Hale, Department of Land Resource Science, University of Guelph * Spencer Hensen, University of Guelph * Arthur R. Hill, Department of Food Science, University of Guelph * Richard A. Holley, Department of Food Science, University of Manitoba * Rebecca Irwin, Antimicrobial Resistance Unit, Laboratory for Foodborne Zoonoses, Health Canada * Roger Johnson, Laboratory for Foodborne Zoonoses, Health Canada * Mohamed Karmali, Laboratory for Foodborne Zoonoses, Health Canada * David Kelton, Population Medicine, University of Guelph * Magalena Kostrznska, Molecular and Cellular Biology, Agriculture and Agri-food Canada * Anna Lammerding, Microbial Food Safety Risk Assessment, Laboratory for Foodborne Zoonoses, Health Canada * Anna T. Lawniczak, Mathematics and Statistics, University of Guelph * Ken Leslie, Department of Population Medicine, University of Guelph * Zuewen Lu, Biometrician, Food Research Program, Agriculture and Agri-Food Canada * John Lynch, Laboratory Services Branch, Ontario Ministry of the Environment * Elroy Mann, Epidemiology and Surveillance Section, Laborataory for Foodborne Zoonoses, Health Canada * S. Wayne Martin, Department of Population Medicine, University of Guelph * Beverly McEwen, Veterinary Pathologice and Disease Surveillance Specialist, Animal Health Laboratory, University of Guelph * Scott A. McEwen, Department of Population Medicine, University of Guelph * Robin C. McKellar, Food Research Program—Food Preservation Technologies, Agriculture and Agri-Food Canada * Lynn McMullen, Food Microbiology, University of Alberta * W. Bruce McNab, Epidemiology & Risk Assessment, Ontario Ministry of Agriculture and Food * Donald G. Mercer, Commercialization Officer, Food Research Program, Agriculture and Agri-Food Canada * Ramon Mira de Orduna, University of Guelph * Gauri S. Mittal, School of Engineering, University of Guelph * Lucy M. Mutharia, Department of Microbiology, Universityof Guelph * Zul Nanjee, Program Specialist, Beef, Food of Animal Origin, Canadian Food Inspection Agency * Joseph Odumeru, Regulatory Services, Laboratory Services Division, University of Guelph * Puni Piyasena, Food Research Program—Food Preservation Technologies, Agriculture and Agri-Food Canada * Cornelius Poppe, OIE Reference Laboratory for Salmonellosis, Laboratory for Foodborne Zoonoses, Health Canada * Douglass A. Powell, Department of Plant Agriculture, University of Guelph * John F. Prescott, Departhment of Pathobiology, University of Guelph * Kris Rahn, Laboratory for Foodborne Zoonoses, Health Canada * Susan Read, E.coli Typing Laboratory, Laboratory for Foodborne Diseases, Health Canada * Richard J. Reid-Smith, Epidemiologist, Laboratory for Foodborne Zoonoses, Health Canada * Susan Sabatini, Department of Population Medicine, University of Guelph, Parviz M. Sabour, Molecular and Cellular Biology, Agriculture and Agri-Food Canada * Tony Savard, Agriculture and Agri-Food Canada * Heidi Schraft, Department of Food Science, University of Guelph * Tom Waddel, Laboratory for Foodborne Zoonoses, Health Canada * David Waltner-Toews, Department of Population Medicine, Universityof Guelph * Haifeng Wang, Department of Food Science, University of Guelph * Keith Warringer, University of Guelph * Roger Wheatcroft, Molecular and Cellular Biology, Agriculture and Agri-Food Canada * Diane Wood, A&P * Janet M. Wood, Department of Microbiology, University of Guelph