8

Implementing on-farm food safety programs in fruit and vegetable cultivation

B. J. Chapman and D. A. Powell,
University of Guelph, Canada

8.1 Introduction

The phone rings at a farmer's house. A buyer at the other end says that health officials have linked an outbreak of foodborne illness to a specific commodity - the farmer's commodity - and are requesting that the producer provide documentation supporting the safety of the product. In the meantime, a public statement will be issued and sales will most likely decline; further, borders for exports could be closed.

Canadian fresh fruit and vegetable producers have only been implicated as the source of two outbreaks of food borne illness since 1981 (Sewell and Farber, 2001; Strauss *et ai.*, 2002). However, this lack of identifiable outbreaks in the past provides little in the way of protection against future associations, given better surveillance and increasing consumption of fresh fruits and vegetables.

There have been over 400 known produce-related outbreaks in North America since 1990, resulting in over 21000 illnesses (CSPI, 2004). There have been thousands of outbreaks without identified causes. The level of public and buyer understanding has risen steadily since the mid-1990s. The adoption of an on-farm food safety (OFFS) program can help producers reduce food safety risks and retain, even expand, market share, strengthening relationships with customers and consumers through proactively addressing risks and creating trust.

Nevertheless, anyon-farm food safety program has limitations, including: appropriate paperwork and documentation; dissemination of evidencebased information to producers; the role of third-party audits versus producer-driven verification; and, the source and allocation of resources to pay for such programs. Further, while the hazard analysis and critical control point (HACCP), or HACCP-based approach to controlling food safety risks has merit, attempts to turn producers into HACCP experts are often misguided.

HACCP is based on the control of critical points in food production: that control must be verifiable and must have been proved to be verifiable in research studies. Because there is still little known about the mechanisms of how fresh produce becomes contaminated on-farm, HACCP purists argue that it is almost impossible to define true critical control points in fresh fruit and vegetable production, and the terminology is often misused. The US Food and Drug Administration (FDA), the United Fresh Fruit and Vegetable Association and the International Fresh-cut Produce Association suggest that because critical control points are, at this point, unachievable, a true HACCP system is too rigid for the farm. A HACCP-based program that incorporates the principles of carrying out a risk assessment and establishing points of control where good agricultural practices are applied can be effective in reducing risks on the farm. Regardless of the acronym, any program must be practical, credible and cost-effective. Guidelines must be accompanied by aggressive implementation, documentation, verification, incentives and, most importantly, support. Individual producers do not need to become food safety experts, but they do need, and usually want, to do the right thing.

Effective on-farm food safety programs have a mechanism to effectively and efficiently document risk-reduction practices. The documentation provides a quick reference to specific practices for interested buyers or for regulators in the case of an outbreak. The documentation medium does not matter, whether it is a checklist that is posted on the wall, a computer spreadsheet or a notebook, as long as it is accessible, complete and current. Verification provides a producer with a record of how well an on-farm food safety program is being implemented, can reveal potential areas of concern and, over time, can provide data that demonstrate continuous improvement in terms of risk reduction. It is not enough to provide a set of guidelines from a government agency or producer association and expect growers to comply with standards. Industry organizations and their producer members must be provided with on-going, evidence-based information, a dialogue of support that can promote the adoption of new practices. Effective on-farm food safety programs require a variety of components that alone are meaningless, but together, provide evidence demonstrating proactive producer-led, risk reduction. In short, on-farm food safety programs should be clearly

designed so producers can: say what they do; do what they say; and verify that it works.

8.2 Systems controlling foodborne illnesses

Outbreaks of foodborne illness, traced to a variety of different foods, can be found worldwide. It has been estimated that there are 76 million incidents of food borne illnesses in the USA each year (representing approximately one-in-four citizens (Mead *et aI.,* 1999»; Australian authorities have also validated this estimate (one-in-four citizens, (OzFoodNet Working Group, 2002».

There has been a continued rise in reported outbreaks of foodborne illness associated with the consumption of fresh fruits and vegetables. Bacteria, viruses and parasites on fruits and vegetables have been linked with illness. In Canada, 18 outbreaks were documented from 1981 to 2000, with approximately 2000 people affected and 18 deaths. Alfalfa sprouts, cantaloupe, lettuce, raspberries and parsley are included amongst the implicated vehicles. The very nature of produce that makes it healthy - fresh and consumed raw - is what makes fresh produce a high-risk food for microbial contamination. Without the microbiological kill step provided by cooking, produce is vulnerable to contamination from the farm-to-fork.

Pathogens can contaminate at any point along the food chain, at the farm, packing shed, processing plant, transportation vehicle, retail store or food service operation, and the home. By understanding where potential problems exist, it is possible to develop strategies to reduce risks of contamination (Tauxe *et al.,* 1997). Raw produce can become contaminated with pathogenic and non-pathogenic microorganisms at a number of different stages, by several means, from production through to consumption. Laboratory studies have found that fresh produce can support the growth of organisms such as *Salmonella*. *Shigella* and *Escherichia coli* 0157: H7. Consequently, methods of growing, handling. processing, packaging and distribution of fresh produce have received increased attention in terms of identifying and minimizing microbiological hazards. The produce industry has now focused on developing and implementing programs aimed at reducing foodborne disease and illness. Complete HACCP systems can never be implemented in fresh produce operations, as there is no definite kill step, such as pasteurization. Instead, these HACCP-based systems help to identify and reduce the potential for microbial contamination along the entire production and distribution process. A successful program helps to avoid recall campaigns, adverse publicity, loss of sales and serves to enhance public health. There is value in applying the steps of HACCP to fruit and vegetable production, using available scientific information as part of the framework, to reduce the risk of foodborne pathogens.

8.2.1 HACCP-based programs

HACCP is a system of food safety control based on a systematic approach to the identification and assessment of hazards associated with food operations and the definition of means for their control. This approach focuses on prevention and control and is advocated for every stage in the food chain, from primary producers through to the final consumer (California Strawberry Commission, 1998; International Fresh-cut Produce Association and Western Growers Association, 1997; United Fresh Fruit & Vegetable Association, 1997).

HACCP has gained recognition throughout the developed world as the best food safety assurance system currently available. It has been recommended by the US National Academy of Sciences and the World Health Organization's Codex Alimentarius Committee, as well as the US Food and Drug Administration (FDA) as an effective and workable approach to food safety control, which can be incorporated into a total quality management program (US Department of Agriculture Food Safety and Inspection Service, 1989). Besides its preventive nature, the HACCP system exercises control over the manufacturing process at critical stages which are known as critical control points (CCPs), detecting or correcting defects which might have an impact on the safety and wholesomeness of the product before its packaging and distribution (Food Safety Enhancement Program, 1993). Until the introduction of HACCP, end-product testing was used as a means of assessing food safety, whereby a percentage of samples were taken for microbiological, chemical or physical testing to determine if the product met with the customer's acceptance criteria. However, a number of limitations to this approach have been recognized, usually summarized by the maxim, 'You cannot test your way to a safe food supply'. Testing has a role in verification of HACCP plans or in establishing critical limits for CCPs, but is limited by sampling plans that are based on the probability of a fault being identified from a representative number of samples being tested. The HACCP approach to food safety moves away from testing of the final product, and instead emphasizes raw material and process control, providing a structured and systematic approach to the control of identified hazards.

The application of the HACCP system consists of a logical sequence of twelve steps encompassing seven basic principles, which can be implemented in any food industry. Recently, HACCP-based programs have been extended to the on-farm environment as a way to reduce risks associated with commodities before they enter the processing environment. However, there is still little known about the mechanisms whereby produce becomes contaminated, so HACCP purists argue that it is almost impossible to define true critical control points in fresh fruit and vegetable production. The FDA, the United Fresh Fruit and Vegetable Association and the International Fresh-cut Produce Association suggest that because critical control

points are unachievable, a true HACCP system is too rigid for on the farm. A HACCP-based program that incorporates the principles of carrying out a risk assesssment and establishing points of control where good agricultural practices (GAPs) are applied has been shown to work in reducing risks on the farm (Powell *et al.*, 2002; Luedtke *et al.*, 2003).

Some have suggested that actions controlled by human behavior - such as handwashing, or the application of agricultural chemicals - be considered as CCPs. Others, however, have noted the difficulty in monitoring human behavior versus monitoring pasteurization temperatures or other mechanically monitored activities. Nevertheless, reliance on well-developed and consistently performed standard operating procedures (SOPs) and GAPs can simplify the HACCP-based plan.

The FDA states that growers, packers and shippers are urged to take a proactive role in minimizing food safety hazards potentially associated with fresh produce (US Food and Drug Administration. 1998). Being aware of. and addressing, common risk factors can result in a more effective, cohesive response to emerging concerns about microbial hazards and fresh produce. Furthermore. producer associations should encourage the adoption of safe practices by their partners along the farm-to-table food chain.

Developing an on-farm food safety program for a specific commodity by relying on generic formulations may not be effective for multitude of horticultural commodities. Basing programs on generic horticultural GAPs can work, but the implementation of programs by individual producers must be flexible and adaptable to various types of farms. .

Recent public interest in microbial food safety and dietary concerns indicates that food safety risk management systems must be both scientifically credible and publicly accountable. On-farm risk management systems such as food safety programs are becoming the cost of doing business and can enhance public trust if the industry can verify what they say they are doing. To this end. open and transparent communication of the potential risks encountered on the farm, how they are addressed and producer compliance is essential. Buyers and government drive the need for food safety standards. These two groups. and sub-groups within each, possess different needs that can lead to various sets of standards for the same product. Industry-led. on-farm food safety programs can provide the infrastructure to create a dialogue with buyer and government groups regarding action taken to ensure a commodity sector is producing safe food. with results in hand to demonstrate compliance.

The recent North American BSE situation has provided an extreme example of how a food safety issue can have an impact on an industry quickly and extensively through trade restrictions; implementing an onfarm food safety program to reduce potential for food safety risks provides mechanisms to minimize impact when a food safety issue arises.

Nevertheless. one of the primary incentives for on-farm food safety programs is to maintain market share and strengthen relationships with

customers and consumers by enhancing trust by a proactive program. The voluntary approach taken through Environmental Farm Plans in the Canadian province of Ontario is a good model for on-farm food safety compliance: liability concerns ensure that producers participate.

8.3 Existing guidelines and OFFS programs for fresh fruit and vegetables

There are a variety of generic and specific guidelines for safe fresh fruit and vegetable production in North America (for a summary of all on-farm food safety programs see Appendix 1). These programs are generally based on RACCP and many are also based on the US FDA's *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables* published in 1998.

Basing programs on RACCP principles provides scientific credibility for the guidelines only. Producers still need to be able to prove they are implementing the guidelines and continually monitoring all control points, including employee sanitation. The majority of on-farm food safety programs for fruits and vegetables in Canada are composed solely of these RACCP-based guidelines with little verification of producer implementation.

GAPs include:

- equipment maintenance program
- sanitation program within facilities/packing area end
- of season
- washroom facilities
- employees
- pest control program
- storage maintenance program
- transportation program
- microbiological sampling.

As fresh fruit and vegetable food safety management is in its infancy, interested individuals and groups are hoping to capitalize on the potential for verification schemes, traceability implementation and guideline design - all at the cost of individual producers. Producers need to lead the discussion about on-farm food safety, in a regional manner, to allow flexibility of programs, keep control close and best fit into the needs of buyers.

Verification provides an evaluation of the risk-reduction steps that are being recorded in a producer's documentation, and is continuously undertaken. Verification provides a producer with a record of how well the onfarm food safety program is being implemented, can reveal potential areas of concern and, over time, can provide the data that demonstrate

improvement. Verification can also be provided for a buyer to demonstrate that the program is accomplishing its goals. Audits can provide a snapshot of a producer's facilities and documentation, but many auditors lack the microbiological or chemical testing capabilities, or interest, that can enhance a program's credibility. Openly providing sample testing methodology and results for a buyer can demonstrate that a producer has nothing to hide and that appropriate steps are effectively being taken to produce safe food.

Communication with employees is an integral part of an on-farm food safety program. Poor employee hygiene has been responsible for over 40% of source identified produce-related outbreaks (Bean and Griffin, 1990). Agricultural employees are on the frontlines of food safety, and providing program ownership for them by setting a good hygiene example, providing effective training and making available current food safety information demonstrates to employees that food safety is non-negotiable. Food safety co-ordinators, either as employees or consultants to individual growers or producer groups. may be best suited to accomplish these tasks.

8.4 Adoption of OFFS - grower perceptions, practical solutions, experiences from the field

The philosophy behind auditing is to provide verification. An audit on its own does not promote the culture of food safety, a culture in which management and employees understand what they need to do, why, and how to reduce food safety risks on the farm.

Researchers have identified three types of barriers to successful implementation of HACCP-based programs including: knowledge barriers - knowing about and understanding the program; attitudinal barriers agreeing with the principles of the program and believing that actions will have an impact on food safety; and. behavioral barriers such as allocating resources including time, money and staff. It is not enough to provide a set of guidelines and expect growers to comply with standards. Industry organizations and their producer members must be provided with ongoing information, a two-way dialogue of learning and support that will promote the adoption of new practices. Recent research has shown that producers prefer to have on-site visits when learning about production practices and will implement procedures correctly when shown them in terms specific to their site. (Maddox *et al.,* 2003). On-farm food safety programs should not waste money by putting producers in classrooms: funds need to be invested into effective on-site visits.

Coaching producers through on-site visits provides the program requirements in specific terms on individual farms and encourages participants to

ensure they are actively implementing, monitoring and maintaining their own on-farm food safety program. Visits should be on-going and occur on a schedule, ideally at least once or more per season. During these visits, participants receive materials for their operations such as hand sanitizers and sign age, receive training materials for farm workers, have food safety put into terms that are specific to their site and are provided with a forum where potential risk issues can be discussed.

It is has been found that it is not enough simply to provide producers with a manual of food safety guidelines and expect full implementation and documentation (Powell *et ai.,* 2002, Luedtke *et ai.,* 2003). Evaluation of onfarm food safety programs found that simple manuals were not effective in overcoming the barriers to implementing the on-farm food safety program. Workable food safety programs must provide individual support for growers. A food safety coordinator can provide the one-on-one support that is needed and evaluation of such programs has indicated that this one-onone support is one effective tool to overcoming these barriers.

Good on-farm food safety programs have a mechanism to keep records of risk-reduction practices. The documentation provides a quick reference of specific practices for interested buyers and, or also, for regulators in case of an outbreak without an in-depth investigation. Documenting when equipment sanitation occurs, what chlorine levels are in wash water or when an employee is sick, demonstrates that food safety is a priority. The documentation medium does not matter, whether it is a checklist that is posted on the wall, a computer spreadsheet or a notebook, as long as it is accessible, complete and is kept up-to-date.

Communication of program goals and risk reduction practices with employees is an integral part of an on-farm food safety program. Agricultural employees are the front line barrier for food safety, and providing program ownership for them by setting a good hygiene example, providing effective training and passively posting current food safety information shows employees that it is important and can improve an employee's practices. An external communications network is necessary to support the program proactively, as well as reactively. Following food safety issues such as outbreaks or potential contamination incidents, representatives need to be ready to respond to public questions through the media.

8.5 Examples from Food Safety Network on-farm food safety research

After three years of research by the Food Safety Network with the same farming community, it was found that producer understanding of food safety issues was dependent on a personal experience, similar to previously reported agronomic information transfer (Maddox *et ai.*, 2003).

Anecdotally, it has been observed that if a producer has had incidents of foodborne illness in the past or has witnessed the effects of such, they are more likely to implement a food safety program vigilantly. The use of the verbal narrative in the form of recent food safety media coverage was well received by many producers (Chapman and Powell, 2004).

Remaining up-to-date on the documentation and recording of practices was identified as an implementation barrier because it is time-consuming and the priority of food safety does not appear to be static with many growers. While food safety is recognized as being important. it is not always viewed as important as other farming issues such as selling prices or the costs of inputs. This is not surprising. as a farmer will not receive any additional price premiums for a product that has been produced following a program, or any documented GAPs. The variability of food safety as a priority with producers was realized when dealing with producers who had the same problems in consecutive seasons, such as a poor equipment sanitation record, though reported that they were following procedures.

Conversely, it was found that producers who did not have food safety issues (such as microbial contamination) in prior years were less trusting of researchers' suggestions to change practices. citing that it had never been a problem in the past. Passively providing information to support an on-farm food safety program was not widely utilized. The majority of producers received the information but did not always read the suggestions or make changes on their sites. This supports the need for various communication vehicles when implementing on-farm programs. On-site visits, phone calls. use of a website, newsletters, faxes and meetings should all be available to make the most impact; trust was built up with producers by being available for questions by every means.

Being too accessible and promoting safe food handling and the reasons behind a food safety program were not always seen as positive. One farmer mentioned that the implementation of the on-farm food safety program was a way for researchers to create more work for themselves; that the program was an attempt to increase reliance through fear. He also maintained that food safety was a myth and people have always dealt with the problems with no consequences.

The ability of producers to communicate effectively with their employees is also a significant barrier, implying that there is an inability for producers to convey reasons for on-farm food safety and control measures. Thus, good communication is not a barrier, bad communication is, and can reduce the effectiveness of program implementation. Providing employees with the tools and a training program is not enough. One farmer relayed an anecdote in which new toilets were installed: all the employees had been provided with latex gloves and instructed when to use them. Within a week of the training an employee with gloves on was seen urinating on the outside of a bathroom unit (which had been installed in a greenhouse on a cement pad). The producer felt that he needed to increase his own vigilance

in explaining the consequences of the unhygienic practices, at all times, but could not watch his employees at all times.

8.6 Conclusions: best practices for an ideal OFFS program for fresh fruit and vegetables

On-farm food safety programs should not waste money by putting producers in classrooms; funds need to be invested in effective on-site visits. On-going research and continuous evaluation is required not only to understand sources and pathways of contamination better, but also to, for example, determine the most-effective ways of communicating with employees, to develop more practical documentation and to integrate on-farm food safety programs better, with nutrient management plans, spray records and environmental farm plans to create a farm-specific approach to produce production.

The components of a complete on-farm food safety system include:

- transparency;
- developed with input from both growers and buyers for acceptance; based on
- the best available science;
- flexible and continuously evolving and improving;
- easy to understand for producers, buyers and consumers;
- providing support for individual growers;
- ensuring understanding of the requirements, documentation and principles;
- utilizing multiple strategies to reduce knowledge, attitude and behavioral barriers;
- efficient and inexpensive; and,
- well documented.

There is no single correct way to include all of the items that are components of an on-farm food safety program; rather, programs should be tailored to the needs of different customers with the goal of retaining or even enhancing market share. The components of a program must also be flexible enough to include the smallest of growers while catering for the needs of large growers.

8.7 References

BEAN N H and GRIFFIN P M (1990), 'Foodborne disease outbreaks in the United States, 1973-1987: pathogens, vehicles, and trends', *J Food Prot*, 53 (9),804-17.

CALIFORNIA STRAWBERRY COMMISSION (1998), *Quality Assurance Program*, Watsonville, California, details on CD.

CHAPMAN B J and POWELL 0 A (2004), 'An evaluation of food safety information transfer to employees: one-page media summary sheets in food service and

agriculture', presented August 10,2004, *International Association for Food Protection Annual Meeting*, Phoenix, Arizona.

CODEX (1996), *Codex Committee on Food Hygiene Draft HACCP Principles in HACCP: Principles and PraCtice,* M D Pierson and D A Corlett (eds), Chapman and Hall, New York.

CSPI (CENTER FOR SCIENCE IN THE PUBLIC INTEREST) (2004), *Outbreak Alert 2004 Closing the Gaps in Our Federal Food-Safety Net*, CSPI, Washington DC

FOOD SAFETY ENHANCEMENT PROGRAM (1993), 'For processing establishments and shell egg grading stations registered with agriculture Canada', *Implementation Manual*, Agriculture Canada, Ottawa ON, Canada.

INTERNATIONAL FRESH-CUT PRODUCE ASSOCIATION AND WESTERN GROWERS ASSOCIATION (1997), *Voluntary Food Safety Guidelines for Fresh Produce*, Alexandria, Virginia, 32 pp.

LUEDTKE A, CHAPMAN B and POWELL D A (2003), 'Implementation and analysis of an on-farm food safety program for the production of greenhouse vegetables', *J Food Pro£*, **66** (3),485-9.

MADDOX S J, MUSTIAN D R and JENKINS D M (2003), 'Agricultural information preferences of North Carolina farmers', presented at *Southern Association of Agricultural Scientists, Agricultural Communications SeCtion*, Mobile, Alabama, February 2003.

MEAD P S, SLUTSKER L, DIETZ v, MCCAIG L F, BRESEE J S, SHAPIRO C, GRIFFIN P M and TAUXE R v (1999), 'Food-related illness and death in the United States', *Emerging Infectious Diseases*, 5 (5),607-25.

OZFOODNET WORKING GROUP (2002), 'Foodborne disease in Australia: incidence, notifications and outbreaks', *Annual Report of the OzFoodNet Network, 2002.*

POWELL D A, BOBADILLA-RUIZ M, WHITFIELD A, GRIFFITHS M G and LUEDTKE A (2002), 'Development, implementation and analysis of an on-farm food safety program for the production of greenhouse vegetables in Ontario, Canada', *J Food Pro!*, **65** (6),918-23.

SEWELL A M and FARBER J M (2001), 'Foodborne outbreaks in Canada linked to produce', *J Food PrOt*, 64 (11),1863-77.

STRAUSS B, FYFE M, LOUIE K, MARTIN S, PACCAGNELLA A and FUNG J (2002), 'An outbreak of *Shigella sonnei* associated with eating or handling raw spinach, British Columbia., Canada, 2001', *TEPHIN ET Global Scientific Conference*, June 2002, Madrid. Spain.

TAUXE R, KRUSE H, HEDBERG C, POTTER M, MADDEN J and WACHSMUTH K (1997), 'Microbial hazards and emerging issues associated with produce, A preliminary report to the National Advisory Committee on Microbiologic Criteria for Foods',] *Food Prot,60* (11),1400-8.

us DEPARTMENT OF AGRICULTURE FOOD SAFETY AND INSPECTION SERVICE (1989), *A Margin of Safety: The HACCP Approach to Food Safety Education ProjeCt Report,* US Department of Agriculture, Washington DC

us FOOD AND DRUG ADMINISTRATION (1998), *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables*, US Department of Health and Human Services, Food and Drug Administration and Center for Food Safety and Applied Nutrition, Washington, DC

UNITED FRESH FRUIT & VEGETABLE ASSOCIATION (1997), *Industrywide Guidance to Minimize Microbiological Food Safety Risks for Produce,* Washington, DC, 16 pp.