ON-FARM FOOD SAFETY GUIDELINES FOR GREENHOUSE VEGETABLES

ONTARIO GREENHOUSE VEGETABLE GROWERS ASSOCIATION

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Foreword

The combination of an estimated 2.2 million cases of foodborne illness annually in Canada and high-profile international outbreaks of foodborne illness related to fresh fruits and vegetables has the potential to undermine public confidence. Other factors such as globalization, production efficiency techniques, and the high level of uncertainty surrounding existing and emerging foodborne risks—all coupled with an unprecedented public interest in microbial food safety and dietary concerns—mean that food safety risk management systems must be both scientifically credible and publicly accountable.

The 1993 outbreak of renal failure, hemorrhagic colitis and death due to *E. coli* O157:H7 contamination of hamburgers in the U.S. associated with the Jack-in-the-Box restaurant chain, had an immense impact on public confidence in the safety of meat (Powell and Leiss, 1997). It also fundamentally changed the food safety policies of many farming, processing and retail industries, as well as the activities of public agencies charged with food safety (CODEX, 1996; FSIS, 1994.). In many respects this outbreak was just one more example of what has been known for years: foodborne disease is a serious public health problem and contamination of food animals and their products (meat, milk and eggs) is a major issue for the food animal industry, all the way from "gate to plate." Food safety, especially microbial food safety, is now a top priority.

Similar attention is now being focused on the fresh fruits and vegetable sector as a significant source of foodborne illness (U.S. Food and Drug Administration, U.S. Department of Agriculture and U.S. Centers for Disease Control and Prevention, 1998; Tauxe, et al., 1997). As North America consumers increase per capita consumption of fresh vegetables, methods of handling, processing, packaging and distributing produce locally and internationally are receiving more attention in terms of identifying and controlling microbiological, chemical and physical hazards.

All sectors of the food industry have a responsibility and interest in ensuring food safety (Council for Agricultural Science and Technology, 1994). The stability of local, national and international markets depends on consumer confidence and buying patterns. Industries are demanding food safety assurances from their suppliers and this is creating tremendous upstream demand for effective pathogen and chemical contaminant control strategies. Food service and processing

industries have been making significant advances through application of the Hazard Analysis and Critical Control Point (HACCP) approach to food safety. HACCP programs are now being used in various sectors of the food industry.

It is important to maintain control over the entire farm-to-fork food production process in order to avoid recall campaigns, adverse publicity and loss of sales in the event of an outbreak of foodborne illness associated with a specific product; or even simply an allegation. Agri-food consolidation and increased processing and distribution networks means that single mistakes in terms of product contamination can be magnified into national or international recalls. Food producers and others along the farm-to-fork food chain have the responsibility to ensure the safety and quality of their products. This preventive, proactive role of industry is a greater safeguard for the health and safety of consumers than the reactive measures that regulatory agencies are forced to take after problems arise.

The purpose of this document is to provide practical and comprehensive guidance to ensure the production of safe produce, based on a systematic approach to the identification of potential sources of microbiological hazards associated with fresh produce, primarily tomatoes, cucumbers and peppers, and the definition of means for their control. Similar to a HACCP system, this approach focuses on prevention and control and is advocated for every critical stage in the processing chain.

This guidance does not address other hazards to the food supply or environment (such as fungicides or chemical contaminants), nor address proper handling regimes to ensure the safety of fresh produce at retail, foodservice, or in the home, which are also important links in the farm-to-fork pathway. Further, this document is a guideline only, leaving each grower and processor with the flexibility to implement in a manner suitable for individual operations.

The following guidelines are consistent with those published by the U.S. Dept. of Agriculture and the U.S. Food and Drug Administration, and the Canadian Horticulture Council. As increased information and new technologies permit better understanding of the factors impacting identification and reduction of risks within the fresh vegetable industry, the guidelines provided herein will evolve.

Hazard Analysis Critical Control Points (HACCP)

Hazard Analysis Critical Control Points 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 (Bryan, 1988). This approach focuses on prevention and control and is advocated for every stage in the food chain, from primary producers up to the final consumer (California Strawberry Commission, 1998; International Fresh-cut Produce Association and Western Growers Association. 1997; United Fresh Fruit & Vegetable Association. U.S. 1997).

It is widely recognized that the first application of HACCP to food safety was at the Pillsbury Company in the 1960s, when developing safe foods for the American space program. The HACCP system had to ensure “zero” defects during food handling by monitoring the whole preparation process. It had to identify and correct errors before they happened, rather than using the traditional method of test sampling the finished product to identify foods with high levels of contamination (Stringer, 1994; Bryan, 1988).

HACCP has gained recognition throughout the developed world as the best safety assurance system developed to date. It has been recommended by the U.S. National Academy of Science and the World Health Organization's Codex Alimentarius committee, as well as the U.S. Food and Drug Administration (FDA) as an effective and workable approach to food safety, control, and can be incorporated into a total quality management program (U.S. Department of Agriculture Food Safety and Inspection Service, 1989).

The main objective of Agriculture and Agri-Food Canada's Food Safety Enhancement Program (FSEP) is to encourage the adoption of HACCP principles that may help to ensure the consistency of food safety programs across all agri-food commodity groups in Canada (Food Safety Enhancement Program, 1993).

Besides its preventive nature, the HACCP system exercises control over the manufacturing process at critical stages which are known as critical control points (CCP), detecting or correcting defects which might 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-like 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, as recognized by the U.S. Food and Drug Administration, true on-farm HACCP systems are unachievable for produce because there are no critical control points such as pasteurization that can be applied. However, HACCP principles can guide development of on-farm food safety programs.

More important for the on-farm environment of greenhouse vegetables, yet consistent with the HACCP framework, are standard operating procedures (SOPs), based on Good Agricultural Practices (GAPs). The primary difference when compared to a true HACCP program is that prerequisite programs based on SOPs can include objectives other than food safety, and that occasional deviation from a prerequisite program requirement would not by itself be expected to create a food safety hazard or concern. CCPs represent, by definition, critical points in food production that could compromise food safety and identified CCPs, again by definition, depend on eliminating the hazard. Control points exist within a prerequisite program, but critical control points should be covered by a HACCP plan (Sperber, et al., 1998).

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

An additional key difference is that while prerequisite programs may impact upon the safety of a

food, they also are concerned with ensuring that foods are wholesome and suitable for consumption. HACCP plans are narrower in scope, being limited to ensuring food is safe to consume.

Prerequisite programs are generally based upon Good Management Practices (GMPs) and/or GAPs, but can also include consumer complaint management, traceability programs and supplier approval programs. Food safety programs, based on HACCP principles, rely on a thorough knowledge of the hazards and risks present on farms and a thorough understanding of GMPs .

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

For the above reasons, the remainder of this document will be devoted to developing comprehensive guidelines as part of a comprehensive on-farm food safety program that can be adhered to by any producer within the OGVGA. This guide focuses on risk reduction not risk elimination.

On-farm food safety program

The present guidance is focused on the identification and control of potential sources of microbiological contamination along the fresh produce pathway. The document provides data sheets (DS) that can be used by growers and employees to document that all actions have been completed and that can be verified by a third party as necessary.

Producers within the OGVGA are required to have developed procedures aimed to control the operational conditions within the establishment (greenhouses, packinghouses, shippers) for the production of safe food (DS-1, part A). The main elements of potential sources of microbiological contamination and the procedures for its control have been identified as follows:

- **Premises**
- **Equipment**
- **Transportation and storage**
- **Personnel**
- **Sanitation and pest control**
- **Trace back system**

These elements will be described in detail for greenhouse vegetable production along the pre-harvest, harvest and post-harvest stages.

Premises

Premises include all elements in the greenhouse, packingshed and surroundings: the outside property, roadways, drainage, product flow, sanitary facilities, and water quality.

Pathogenic bacteria gain entry from air, water, animals, raw materials, dust, dirt and people. Therefore, establishments should have written programs featuring procedures to ensure the maintenance of buildings' satisfactory condition.

- *Individual identification*

To develop and implement an individual program, the name, address, and location for each grower and greenhouse location, should be provided. For every premise, an individual, manager or employee should be designated as the official on-farm food safety supervisor. (DS-1, part B)

Greenhouses and other facilities must be of sound construction, maintained in good repair and in sanitary condition to reduce the potential for microbial contamination of produce. Growers are advised to verify the adequate conditions to insure a satisfactory environment of the establishment (DS-2).

- *Structural components of establishments (greenhouses and packing sheds)*
- *Water Quality Program*

Water supply Water is an essential element in the production and handling of produce and is used in numerous operations, including: irrigation, application of fertilizers, crop protection sprays, and produce washing. It is also used for all sanitation practices in the greenhouse and packingshed. Establishments must have a water control program that evaluates the quality of source and in-plant water. Note that operations in which produce is in direct contact with water (dumping tanks) require a correspondingly higher level of attention to water quality compared to uses where there is minimal water to-produce contact.

Water Quality Evaluation (DS-3)

- Identify the source of water used in the different operations. The review may include whether the source of the water is from a well, open canal, reservoir, reused irrigation water, municipal water or other sources; water from unsafe sources has been a frequent cause of enteric infections.

Evaluate the quality of water by microbiological testing done by a recognised laboratory. Water used for processing operations should be safe and sanitary (potable water). Non-potable water should never be used in produce pre-harvest, and post-harvest operations. The type of water source will determine the frequency of tests taken per year. After tests are completed, keep results of all water tests in your files.

- Those operations that use chlorine as a microbiological control in operations where water comes in direct contact with fresh produce (for example dumping tanks) should regularly monitor chlorine levels. Recommended chlorine levels have been reported of 100-200 ppm (free chlorine). However, recognizing the detrimental effect that high levels of chlorine may have on product quality, and recognizing that attention to other GAPs can significantly lower microbial risk on fresh produce, a level of 50-100 ppm chlorine should be sufficient (DS-4).
- Add sufficient overflow water during processing to compensate for the potential build-up of organic materials.
- Establish and document a regular cleaning schedule for dump tanks, flumes and wash tanks with adequate sanitizers.
- Change wash water, and water used for other operations, as frequently as practicable to prevent the build-up of organic material and microbial contaminants.

- Where water is reused for a series of processes, verify that water is used first for those that need the highest water quality as in the final rinse, followed by use in processes where water quality needs are not as great, as in the flume or dump tank water.
- Document all verifications, and corrective actions taken.

Water distribution systems

- Verify that tanks, vessels, and pipes are designed and structured as to prevent contamination, particularly by rodents and other pests, birds, dust and rain. When non-potable water is used it should be carried in separate lines that are readily distinguishable, preferably by colour, from lines carrying potable water.

d) Sanitary facilities

Washrooms and hand washing stations (DS-5)

- Operators should consider the importance of proximity and accessibility of sanitary facilities to harvest crews in all sectors of fresh produce production. Employees should always have the opportunity to use the on an as-needed basis. Sanitary facilities should be maintained in sanitary condition and good repair at all times.
- Document steps taken to ensure compliance for quantity, sanitary condition and maintenance of field toilets, including:
- Average number of employees per week
- Number of toilets in use
- Sanitation procedures and frequency of cleaning
- Individual or company responsible for maintenance and sanitation
- Procedure in place to check and replenish toilet paper, soap, paper towels and fingernail brushes
- adequate employee instruction in proper hand and nail washing techniques
- posted signs in the appropriate language(s) reminding employees to wash their hands and practice good hygiene

Equipment

Field equipment can easily spread germs to fresh produce. Therefore, growers should use adequate designed equipment for harvest and post harvest operations. Harvest personnel are advised to frequently clean and sanitize bins, containers, brushes, buckets, gloves or other harvesting material that comes in contact with the product. Any equipment used to haul garbage, manure, or other debris should not be used to haul fresh produce or have contact with cartons or pallets that are used in contact with fresh produce without first being carefully cleaned. A program should be in place to monitor and control all elements in the area and maintain adequate records as well (DS-6).

Storage and Transportation

Contamination of greenhouse vegetables may occur due to improper practices during handling, storage, loading, unloading, and transportation operations. Consequently, growers are encouraged to pay particular attention to the product as it leaves the field for the cooler, packaging shed, or processing facility, and to guarantee that sanitation requirements are met during each stage. Establish an active and ongoing discussion with transportation personnel to ensure the success of any safety management program. Without a proper dialogue on produce safety risks and the need for adequate sanitation standards any safety steps implemented along the farm to fork pathway may be negated (DS-7, DS-8).

Personnel

Employee written training

Operators should establish and maintain a program to train all employees, including supervisors, full-time, part-time, and seasonal personnel in good sanitation and hygiene practices, and institute a monitoring system to insure instructions are being followed while on duty. Documentation for the general training session (DS-9) as well as for every employee (DS-10), are necessary to verify that federal, provincial and local requirements for worker safety training are met. Good hygienic practices by all personnel who are involved in the greenhouse harvesting, packing and distribution of OGVGA produce is essential in the control of microbial and other biological hazards.

Personnel responsible for training and identifying sanitation failures or produce contamination should have a background of education or experience to provide a necessary level of competency and to promote good sanitary practices (DS-11)

Sanitation and Pest Control

Sanitation program

A written sanitation program must be developed and scheduled in order to ensure good hygienic practices. Develop sanitation procedures for equipment, utensils, floors, drains, lighting devices, refrigeration units, and anything else impacting on the safety of the product (DS-12). For each area and piece of equipment and utensils, the written sanitation program should specify:

- name of the person responsible;
- the chemicals used;
- the procedures used; and
- the frequency of cleaning and sanitizing.

Production should only begin after a pre-operation inspection has been carried out with satisfactory results (DS-13).

Pest control program

An adequate written pest control program should be developed and carried out at the greenhouse and packinghouse as part of the facility's good sanitation procedures (DS-14). Growers should assess the prevalence and likelihood of uncontrolled animal access to greenhouses and packinghouses in order to reduce the potential for contamination of crops by fecal material. Besides the written pest control program, pest problems can be minimized by taking a few precautions, as listed in DS-15.

Trace-back system

A written trace-back program should be designed to outline the procedures the company would implement in the occurrence of a recall.

In the event of an outbreak, lot identification investigations can lead to a specific company source or even field, rather than an entire commodity, thus lessening the economic burden on multiple industry operators not responsible for the problem.

A program must be developed to track individual containers from the farm, to the cooler, to the receiver, in as much detail as possible, and in conjunction with the retail sector. The following type

of program has been suggested by other groups and can form the basis of a future OGVGA program. Trace back coordination

- Use a simple coding system to identify fresh produce in “loads”, at a minimum. An effective lot identification system should have documentation to indicate the source of a product and a mechanism for marking or identifying the product that, ideally, can follow the product from the farm to the consumer (DS-16).
- Coordinate trace back procedures with shipper/handler.
- Maintain a copy of the shipper/handler's trace back procedures for your file
- Verify that documentation includes, date of harvest, farm identification, and chain of custody from cooler to receiver.

The ability to identify the source of a product (positive lot identification) from the consumer back to the grower’s field serves as an important complement to good management practices intended to prevent the occurrence of produce safety problems, and to minimize the impact of foodborne disease outbreaks.

Conclusions

This document forms the basis for the OGVGA on-farm food safety program. OGVGA will be hiring an individual on a full-time, contractually-limited basis beginning May 1, 1999, to assist producers throughout Ontario as they implement the above recommendations and develop appropriate documentation, SOPs and GAPs.

References

Bryan, F.L. 1988. Hazard Analysis Critical Control Point: What the system is and what it is not. J. Environmental Health **7:** 400–407.

California Strawberry Commission. 1998. Quality Assurance Program.

Canadian Food Inspection Agency (CFIA). 1998. Food Safety Enhancement Program, Volume 4. Operational Guidelines, 2nd edition. Appendix II. CFIA. Ottawa.

Council for Agricultural Science and Technology. 1998. Implementation of the Food Quality Protection Act. Statement Presented to the House Committee on Agriculture Subcommittee on Department Operations, Nutrition, and Foreign Agriculture. June 25.

Council for Agricultural Science and Technology. 1994. Foodborne Pathogens: Risks and Consequences. Ames, Iowa.

Codex, 1996. Codex committee on food hygiene draft HACCP principles in HACCP: Principles and practice ed. by M.D. Pierson and D.A. Corlett. Chapman and Hall, New York, NY.

Food Safety Enhancement Program. 1993. For Processing Establishments and Shell Egg Grading Stations Registered with Agriculture Canada. Implementation Manual. Agriculture Canada.

FSIS - Food Safety and Inspection Service, United States Department of Agriculture. HACCP Roundtable March 30-31, 1994. Summary Report. United States Department of Agriculture.

International Fresh-cut Produce Association and Western Growers Association. 1997. Voluntary Food Safety Guidelines for Fresh Produce

Powell, D.A. and Leiss, W. 1997. Mad Cows and Mothers’ Milk. McGill-Queen’s University Press.

308 pp.

Sperber, W.H., Stevenson, K.E., Bernard, D.T., Deibel, K.E., Moberg, L.J., Hontz, L.R. and Scott, V.N. 1998. The role of prerequisite programs in managing a HACCP system. Dairy Food Environmental Sanitation **18:** 418-423.

Stringer, M.F. 1994. Safety and quality management through HACCP and ISO 9000. Dairy, Food Environmental Sanitation **8:** 478-481.

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. J. Food Protect. **11:** 1400-1408.

United Fresh Fruit & Vegetable Association. U.S. 1997. Industrywide Guidance to Minimize Microbiological Food Safety Risks for Produce.

U. S. Department of Agriculture Food Safety and Inspection Service, 1989. A Margin of Safety: The HACCP Approach to Food Safety Education Project Report.

U.S. Food and Drug Administration, U. S. Department of Agriculture, U. S. Centers for Disease Control and Prevention. 1998. Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables. Final Report October 26.

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