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WORKING DRAFT

**GUIDE TO MINIMIZE MICROBIAL
FOOD SAFETY HAZARDS FOR
FRESH FRUITS AND VEGETABLES**

Note: This document is also available for download in [WP 6 format](#) (ZIP compressed).

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GUIDE TO MINIMIZE

MICROBIAL FOOD SAFETY HAZARDS FOR FRESH FRUITS AND VEGETABLES

PREFACE

On October 2, 1997, President Clinton announced a plan to further ensure the safety of the Nation's food supply. The plan, entitled "Initiative to Ensure the Safety of Imported and Domestic Fruits and Vegetables," is geared towards increasing assurances that fruits and vegetables, whether produced domestically or imported, are safe. As part of this initiative, the President directed the Secretary of Health and Human Services, in partnership with the Secretary of Agriculture, and in close cooperation with the agricultural community, to issue guidance on good agricultural practices (GAP's) and good manufacturing practices (GMP's) for fruits and vegetables (Ref X).

In response to this directive, the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) (hereinafter referred to as "the agencies") are issuing "Guide to Minimizing Microbial Food Safety Hazards for Fresh Fruits and Vegetables." This document (hereinafter referred to as "the guide") addresses microbial food safety hazards and good agricultural practices associated with a selected number of factors, i.e., water quality, worker hygiene, transportation, and manure use, common to the growing and harvesting of most fruits and vegetables which are sold to consumers in an unprocessed or minimally processed (i.e., raw) form. The guide, as well as planned guidance for specific fruits and vegetables, will assist growers and operators in continuing to improve the safety of domestic and imported produce.

The agencies plan to issue additional guidance documents addressing good agricultural practices and good manufacturing practices for specific fruits and vegetables in the near future. These additional guidance documents will discuss microbial hazards and good management practices specific to individual fresh market crops and regions. Where applicable for a particular crop, the later documents will include guidance on minimizing microbial food safety hazards at subsequent steps in the food production system beyond those covered in this general guidance document. These specific documents will be accompanied by educational and outreach programs for the fresh produce industry and consumers.

The guide is intended to be guidance only. It does not bind the agencies, nor does it create or confer any rights, privileges, or benefits for, or on, any person. While the guide represents the best advice of FDA and USDA, it does not have the force and effect of law.

From a public health standpoint, the agencies encourage continued increases in the consumption of fruits and vegetables. Therefore, consumers must have confidence that consistently safe and wholesome produce is available. The guide is the first in a series of efforts under the President's initiative, including additional guidance documents for specific fruit and vegetable crops, industry and consumer outreach and education programs, and accelerated research, designed to assist in achieving this goal.

Growers are urged to take a proactive role in minimizing the food safety risks for fruits and vegetables. 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 the microbial safety of fresh fruits and vegetables. Furthermore, growers should encourage the adoption of safe practices by their partners along the farm to table pathway, including food service establishments and home meal preparation, to assure that each individual effort will be enhanced.

INTRODUCTION

The National Cancer Institute recommends that consumers increase their consumption of fruits and vegetables to at least five servings a day to reduce the risk of chronic disease. In the past two decades, there has been a noticeable increase in the consumption of fresh fruits and vegetables in the United States and a marked increase in the year round availability of fresh produce from a global market.

Although the reported incidence of foodborne infection from fresh produce is relatively low, it is increasing. In 1973 - 1987, among those foodborne outbreaks with an identified food vehicle reported to CDC, 2% of outbreaks, and 2% of outbreak-associated cases were associated with fresh fruits and vegetables. In 1988 - 1991, these proportions increased to 5% and 8%, respectively (Ref X). These outbreaks have raised concerns about the safety of foods, including fresh fruits and vegetables, that are not processed to eliminate pathogens.

Fresh fruits and vegetables are not generally subject to many of the steps designed to reduce or eliminate microbial load that processed foods receive. Therefore, taking steps to reduce the risk of microbial contamination is especially important for raw produce. This document is designed to address common elements in the growing, production, and distribution process for fresh fruits and vegetables by focusing on those areas of most significant concern across the produce industry, which when managed properly, will reduce the risk of microbial contamination.

Growers and operators should use the guide as a reference to assess major hazards while further evaluating the unique growing, harvesting and processing practices of their own commodities and regions. The guide is not intended to be a checklist for identifying all potential sources of contamination. Because of the diversity of agricultural practices and commodities, practices to reduce the risk of microbial contamination will be most effective when these general concepts are adapted to specific operations.

Different crops have different physical characteristics and cultural needs that will impact both the potential for contamination from hazards discussed in the guide and the good agricultural practices that are most effective in reducing foodborne illness. Handling will likely be different for crops with highly textured surfaces (e.g., leafy crops and cantaloupes) compared to crops with smooth surfaces or for orchard crops compared to low growing fruits and vegetables. Berry fruits, such as strawberries and raspberries, are delicate and must be handled very carefully. They are not washed after harvest. Thus, wash water quality is not a major source of contamination for these fruits. In contrast, tomatoes picked in the "green" stage are much sturdier and may be packed into large field totes, flushed from these containers with water, and flumed into the packing house. Because of the high degree of water-to-produce contact, tomato growers and operators should assign a high priority to wash water quality. Further, mechanisms and practices to ensure adequate irrigation and soil fertility will vary with the cultural requirements of different crops and with regional differences in soil and climate. Differences in the physical characteristics and handling requirements for different fruits and vegetables grown in different regions need to be accounted for when considering potential microbial hazards and control procedures.

For most enteric pathogens, the ultimate source of contamination for produce is human or animal feces. However, the specific means through which produce is contaminated are varied, and include both direct and indirect transmission. Based on current scientific understanding, potential vehicles or mechanisms for contamination common to most produce operations include, but are not limited to:

- **Water**
- **Manure/Municipal Sewage Sludge**
- **Worker Hygiene**
- **Field and Facility Sanitation**
- **Transportation**

In each of the next sections, the guide will identify the broad microbial hazards associated with each area of concern and the scientific basis for each hazard as best can be determined at this time. Each section will conclude with a series of examples of how microbial contamination can occur along with examples of general good agricultural and management practices for avoiding or minimizing the risks of such hazards. The agencies note that there are a number of significant gaps in their knowledge of the scientific basis for reducing or eliminating pathogens in an agricultural setting. For example, more research is needed to identify time/temperature combinations that would effectively eliminate pathogens, if they are present, from animal manure during composting or other treatment. Thus, the examples of good agricultural practices presented in the guide are not intended to be prescriptive advice that should be compelled for all industry operators. Rather, they are intended to build broad industry understanding and awareness of those practices that individual growers may find necessary to address in their own operations. Growers should recognize that good sanitation practices provide the foundation upon which any food production, handling, and distribution operation supplies safe, wholesome food.

In the last section of this document, the agencies discuss the issue of being able to track fresh produce from consumers back to its source (hereinafter referred to as "positive lot identification"). While it may not be appropriate for the entire fresh fruit and vegetable industry, some operators may want to consider adopting mechanisms to assist positive lot identification as part of their individual management programs.

As additional information emerges, operators should consider adjusting their practices to accommodate these new recommendations. As the need arises, the agencies will update this document, or provide additional guidance.

I. DEFINITIONS

The following definitions are applicable to this guidance document.

x. Adequate means that which is needed to accomplish the intended purpose in keeping with good practice.

x. Composting refers to a managed process in which organic materials are digested aerobically or anaerobically by microbial action.

x. Control means (a) To manage the conditions of an operation to maintain compliance with established criteria. (b) The situation where correct procedures are being followed and criteria are being met.

x. Control measure means any action or activity that can be used to prevent, eliminate, or reduce a hazard.

- x. Facility means the sites and buildings used for or in connection with the harvesting, storage, processing, packaging, labeling, or holding of fruits and vegetables.
- x. Food-contact surfaces are those surfaces that contact fresh produce and those surfaces from which drainage onto the produce or onto surfaces that contact the produce ordinarily occurs during the normal course of operations. "Food-contact surfaces" includes equipment used in agricultural practice.
- x. Microorganisms means yeasts, molds, bacteria, protozoans, and viruses. Occasionally, the term "microbe" or "microbial" is used instead of the term "microorganism."
- x. Microbial Hazard means microorganisms that are reasonably likely to cause illness or injury. This includes bacterial, fungal, and viral pathogens, and other microorganisms, including parasites, that cause food to become a public health hazard.
- x. Operator means the person or persons who have day to day responsibility over all employees who are involved in the production, harvesting, processing, or distribution of fresh fruits and vegetables.
- x. Pathogen means an agent capable of causing disease, especially microorganisms but also includes parasitic organisms.
- x. Pest refers to any objectionable animal or insect including, but not limited to, birds, rodents, cockroaches, flies, and larvae.
- x. Food safety control operation means a planned and systematic procedure for taking all actions necessary to prevent food from becoming unsafe for the consumer.
- x. Sanitize means to adequately treat produce or food-contact surfaces by a process that is effective in destroying or substantially reducing the numbers of vegetative cells of microorganisms of public health concern, and other undesirable microorganisms, but without adversely affecting the product or its safety for the consumer.

II. WATER

Wherever water comes in contact with produce, from irrigation through packing, its source and quality dictate the potential for pathogen contamination. Water can be a concern in two aspects, first as a direct source of contamination, and secondly, as a vehicle for spreading localized contamination in the field, facility, or transportation environments.

A. MICROBIAL HAZARD

Water can be a carrier of certain microbial hazards including pathogenic strains of *Escherichia coli*, *Salmonella* spp. *Vibrio cholerae*, *Shigella* spp., *Cryptosporidium parvum*, *Giardia lamblia*, *Cyclospora cayatanensis*, and the hepatitis A virus. In a survey of waterborne disease outbreaks in the United States for the two-year period 1991-1992, 34 outbreaks were associated with drinking water supplies in which an estimated 17,464 persons became ill (Ref x). *Cryptosporidium parvum*, *Giardia lamblia*, *Shigella sonnei*, and hepatitis A virus were each linked to at least one outbreak during this period. *Cryptosporidium parvum* contaminated the Milwaukee, Wisconsin public water supply in 1993, resulting in the largest outbreak of waterborne disease documented in the United States in which 403,000 people

became ill (Ref x).

It has long been known that the use of contaminated irrigation water results in increased frequency of pathogen isolation from harvested produce (Norman and Kabler, 1953; Dunlop and Wang, 1961).

In 1995, an outbreak of *Salmonella hartford*, *S. gaminara*, and *S. rubislaw* was associated with unpasteurized orange juice served at a theme park in Florida (CDC EPI-AID 95-62). Although the cause of the contamination was not identified, at least one of the groves supplying oranges to the implicated processor irrigated with surface water that may have been contaminated. In 1995, an outbreak of *E. coli* O157:H7 infections involving at least 29 people in Montana was linked to leaf lettuce (CDC EPI-XID-95-68). It is not known where the lettuce became contaminated. However, investigators noted that the lettuce was irrigated with surface water which may be more vulnerable to contamination (e.g., through run off).

In 1990, an outbreak of *Salmonella javiana* infections involving 176 cases in Illinois, Michigan, Minnesota, and Wisconsin, was epidemiologically linked to consumption of fresh tomatoes (Wood). In 1993, 100 outbreak-associated cases of *Salmonella montevideo* infections were identified in Illinois, Michigan, Minnesota, and Wisconsin, and tomatoes were again implicated as the likely vehicle (CDC EPI-93-79). Tomatoes from both outbreaks were traced back to a single packing house. A water-bath used by the packer appeared to be the likely source of contamination and the most practical point for control.

These example outbreaks illustrate some of the difficulty in identifying the source of microbial contamination for fresh produce. Fresh produce with a relatively short shelf-life is often gone by the time an outbreak is reported, making it difficult to identify the item causing foodborne illness. If fresh produce is linked to an outbreak, practices such as using poorly labeled or recycled shipping crates and co-mingling during distribution or at retail hamper identification of the source of a product. If an implicated source (e.g., a field or packing house) is identified, the source of contamination may not be present when investigators take environmental samples. While the agencies do not have sufficient data to determine what proportion of produce is contaminated by water used in agricultural or packing house operations, growers are urged to take a proactive role in minimizing those microbial hazards over which they have some control.

B. CONTROL OF POTENTIAL HAZARDS

Water is an essential element in the production and handling of produce and is used in numerous operations, including: field irrigation, application of fertilizers, crop protection sprays, produce cooling, washing, waxing, and transport. Because of water's potential as a source of pathogenic microorganisms, growers should carefully analyze those practices or processes involving water and seek to limit the possibility for waterborne contamination.

The potential for contaminated water to contaminate produce is influenced by both how it is used and the characteristics of the crop. In general, operations in which produce is in direct contact with water require a correspondingly higher level of attention to water quality compared to uses where there is minimal water-to-produce contact. Thus, for example, water quality may need to be greater for overhead spray irrigation than for drip irrigation. Produce that provide a large surface area and those with topographical features that foster attachment or entrapment are at greatest risk, especially close to harvest.

The first step in evaluating water quality should begin with identifying the source of water used in

different operations and recognizing the potential of various water sources to become contaminated. The proximity of a water source to sewage treatment facilities, livestock operations, or high concentrations of wildlife, and other potential pollution sources, should be assessed and controlled if a potential for contamination exists. Additionally, growers and produce workers should consider water's potential as a vehicle for spreading microbial hazards from one produce item onto others.

On the other hand, water may also be considered as a tool for reducing potential contamination, e.g., to clean produce and equipment for harvesting and transportation. Some sectors of the produce industry use water containing sanitizers to minimize potential surface contamination. Sanitizers approved for food and food processing environments are listed in "List of Proprietary Substances and Nonfood Compounds Authorized for Use Under USDA Inspection and Grading Programs" (USDA, 1997). FDA regulations governing the use of chemicals to wash or assist in the lye peeling of fruits and vegetables are set out in title 21 CFR 173.315. FDA regulations and recommendations on sanitizing solutions for food processing equipment and other food contact articles are set out in 21 CFR 178.1010 and in the FDA Food Code, part 4 - 7 "Sanitation of Equipment and Utensils". –Insert citation for applicable EPA regulations| Technical advice is also available from reputable sanitizer manufacturers and trade associations. The following are a series of examples for growers and operators to consider in assessing water in their own operations and in applying controls to minimize microbial hazards:

1.0 Agricultural Water

- Growers should identify and review the source of water used on the farm. Review may include determining whether the source of the water is from a well, open canal, reservoir, reused irrigation water, a municipality, or other source. This review should also consider potential sources of contamination to the water supply.
- Water may become contaminated, directly or indirectly, by human or animal waste. Potential sources of contamination include human sources, such as septic tanks, and sewage treatment facilities, and animal sources, such as liquid manure lagoons, nearby livestock, or high concentrations of wildlife. These, and other potential sources, should be assessed and controlled if a potential for contamination exists.
- Growers may want to test water for microbial contamination on a periodic basis. The frequency of the testing will depend on the water source. Appropriately constructed closed, underground, or capped well systems are usually not subject to the risk of surface contamination and, therefore, would need to be checked less frequently (e.g., annually). The quality of open water sources and reservoir systems may fluctuate due to environmental influences and, therefore, may need to be tested more frequently (e.g., after influx of run off). Growers may best assure themselves of suitable water quality by testing for *E. coli*. Growers may want to test for additional microorganisms, such as pathogens of major concern, if such microorganisms are a potential or suspected hazard in their operation.
- Where agricultural water quality varies (e.g., an open water source that may be subject to intermittent, temporary contamination such as run-off from livestock operations upstream), growers should be aware of conditions that make the water source more susceptible to microbial contaminants and follow control practices to ensure that water quality is sufficient for its intended use. Controls include many options such as water treatment, alternative application methods that reduce or avoid water-to-produce contact, using alternative water supplies, where available, and delaying water use until water quality improves. The feasibility of these, or other, controls will

depend on the intended water use and the needs and resources of a particular operation.

1.1 Irrigation

Irrigation water should be considered as a potential source of contamination. Contamination of produce by pathogens, and the extent to which it occurs, may be influenced by the source of the water and the method of irrigation employed. Irrigation techniques that expose the plant to direct contact with contaminated water increase the risk of contamination. Thus, for many crops, spray irrigation has a greater potential for spreading contamination than drip irrigation or flooding.

- For irrigation systems using filtration, testing for microbial quality is best done after the filtration system but at a point common to all fields using a given water source.
- The level of microorganisms at which operators may want to institute management practices to reduce the risk of microbial contamination will vary depending on a number of factors, including: the method of water delivery (e.g., a drip station, sprinkler pump, pressure system, or other method), time until harvest, and the physical characteristics of the crop (e.g., orchard fruit or low growing, leafy vegetables). As water-to-produce contact increases, the need for high quality water also increases.
- Growers may need to adopt control practices that will protect the quality of water used for irrigation, such as protecting open reservoirs, where feasible, to reduce the chance of contamination.
- To the extent feasible, growers should follow good agricultural practices that minimize contaminated water being sprayed or otherwise applied to the edible portion of produce, especially close to harvest.

1.1.2 Method of Delivery

The agencies recognize that many factors influence a grower's choice of irrigation system (e.g., economics, water availability, characteristics and cultural requirements for particular crops). Depending on the crop, growers may need to consider using water delivery systems, such as drip irrigation, that minimize direct water-to-produce contact.

1.1.3 Water as a Vehicle for Spreading Contamination

- Water delivery methods, the physical characteristics of the crop, and the topography of the field may affect the potential for irrigation water to serve as a mechanism for spreading contaminants. Growers should evaluate the area and the direction of run off from heavy rainfall and excess irrigation. Growers may want to consider management practices that limit the spread of water or that limit the planting of fresh market crops downhill from possible sources of microbial contamination (e.g., downhill from a cow pasture). Growers may also consider providing physical barriers, e.g., ditches and mounds, where necessary to prevent runoff of contaminants from adjacent fields.
- Current and historical use of adjacent fields should be determined with respect to their potential as sources of contamination. Adjacent lands should not be used for purposes that are incompatible with the growing of food crops.

1.2.0 Crop Protection Sprays

Water used to mix and load pesticide sprays should be considered a potential source of microbiological contamination. Factors such as the degree of exposure, frequency of application, and presence of surfactants, powders or debris in the water or spray, and the biological characteristics of the contaminating microorganism may all influence the risk of waterborne infections.

- Growers should be able to identify the source of the water used for crop protection applications and should be able to verify that the water is of sufficient quality for this purpose.
- When mixing crop protection sprays, growers should use water of adequate quality. Growers may need to consider following good agricultural practices when mixing pesticides to protect the integrity of a primary water source, such as a well, rather than relying on using a secondary water source, such as a river, that may be contaminated. Good agricultural practices might include setting aside an area specifically for mixing crop protection sprays with a water source such as well water stored in intermediate tanks (i.e., tanks used only to hold water, not for mixing pesticides).

2.0 Processing Water

Water is used for numerous operations in the field or packinghouse, many of which involve a high degree of water-to-produce contact. In addition, this water may be reused, which could result in the build-up of heavy microbial loads, including pathogens. While water may be a useful tool for reducing potential contamination, it may also serve as a source of contamination or cross-contamination. Consequently, operators may need to institute good management practices to minimize the risk of microbial contamination from water used for washing and other operations. In addition, some studies have determined that some types of produce absorb water (along with pathogens that may be present) when the product is submerged in dump tanks, when being moved between unit operations by flume water, and by other operations that involve a high degree of water-to-produce contact.

- Water used to wash produce and for other processing operations should be safe and sanitary for its intended use. Generally, water that meets the microbial criteria for potable water would be considered "safe and sanitary." However, the level of water quality needed will vary depending on the operation and where it occurs in the chronology of unit operations that may be applied to fresh produce between harvest and the consumer. For example, water quality needs may not be as great for a dump tank receiving produce from the field, when the dumping operation is followed by additional washing and rinsing treatments. Conversely, treatments towards the end of processing, such as a final rinse before consumer packaging, require higher water quality. In all cases, care must be taken to ensure that washing or other operations do not aggravate food safety concerns.
- Operators may want to sample and test their processing water periodically for microbial contaminants. GMP's for water supply used for food or food contact surfaces in processing facilities are set out in 21 CFR 110.37(a) and 110.80(a)(1) (Appendix A). Where applicable, growers and operators may want to consider applying the guidance in these GMP's to operations in the field and packing house environments.
- Care should be taken that the microbial quality of water, including recycled water, is sufficient for its intended use at the start of the process. Operators may also need to apply practices that ensure that adequate water quality is maintained through out the process. Such practices may include:

monitoring the microbial quality and available chlorine levels in processing water, scheduling water changes as necessary, and adding sufficient make-up or overflow water during processing to compensate for the build-up of organic materials.

- Wash water, and water used for other operations, such as chilling, should be changed as frequently as practicable to prevent the build-up of organic material and microbial contaminants.
- Where water is reused for a series of processes, water use should be in a counter current flow to the movement of produce through different unit operations. For example, water should be used first for processes that need the highest water quality (e.g., a final rinse) followed by use in processes where water quality needs are not as great (e.g., flume or dump tank water).

2.1 Wash Water

- Since most microbial contamination is on the surface of fruits and vegetables, surface treatments can reduce the overall degree of contamination. If pathogens are not removed or inactivated, they can spread so that a significant proportion of the produce is contaminated instead of sporadic items.
- Growers may need to add effective sanitizers or antimicrobials to wash water to help prevent cross-contamination and to increase the efficiency of washing. Chlorine is a commonly used antimicrobial. Chlorine dioxide, hypochlorite, and trisodium phosphate have also been studied for their potential use for disinfecting produce. (Seymour Block, "Disinfection, Sterilization, and Preservation" (4th ed. Lea and Fabiger)) (See also Draft WHO document.)
- Operators may need to monitor chlorine levels during washing and other operations to ensure that they are maintained at an effective level.
- For products that cannot tolerate exposure to water, such as strawberries and raspberries, disinfectant rinses are not an option and alternative treatments might be considered. Such treatments may include: UV radiation, low-dose ionizing radiation (≤ 1 kGy), ozone, or gas-based disinfectants.
- Wash water, even with sanitizers, may reduce but not eliminate, pathogens on the surface of produce. If pathogens are internalized (e.g., some organisms can enter the flesh of tomatoes through the stem scar), washing has even less effect. Thus, steps to ensure water quality and to prevent initial contamination of fresh produce should be emphasized.
- Findings that *Salmonella* in a water bath may be rapidly internalized by tomatoes when the water bath temperature is colder than the tomatoes have led to the recommendation that wash water for tomatoes be hyperchlorinated and 10 degrees F warmer than the tomatoes (Ref X). This recommendation may have application to other products.
- Researchers believe that some products with internal airspaces (such as celery, apples, and tomatoes) may be more susceptible to possible internalization than denser products (such as carrots). For products susceptible to internalization of pathogens, the recommended temperature differential may be achieved either by heating water or by cooling produce before immersion. Where it is not practicable to expose produce to warmer temperatures, such as when there is an overriding need to remove field heat to preserve product quality, good management practices to

minimize pathogens in the water or on the surface of produce are especially important. Such practices may include: using sanitizers in the wash water, using spray-type wash treatments instead of submerging produce, and ensuring that both produce and water are clean before produce is submerged.

- As organic materials and microbial load increases in wash water, the efficacy of sanitizers decreases. Operators may need to consider adopting practices to maintain the efficacy of wash treatments. Such practices may include: an initial wash treatment to remove the bulk of field soil from produce followed by a sanitizing dip and a rinse. The use of surfactants and other agents that may have a synergistic effect with sanitizers is also being investigated.
- The risk of cross contamination may be reduced by segregating, or discarding, poorer quality produce that has a higher risk of contamination.

2.2 Cooling Operations

Water and ice used in cooling operations should be considered a potential source of pathogenic contamination. Constant reuse of water to pre-cool continuous loads of produce increases the need for a high degree of vigilance. An outbreak of shigellosis in 1994, in Illinois, was associated with imported green onions in which CDC determined the likely cause of contamination was packing the produce in ice made from nearby river water (Ref x). An outbreak of *Shigella sonnei* foodborne infection or illness associated with iceberg lettuce was thought to have resulted from the use of fecally contaminated water, either for irrigation or in cooling after packing (Ref x).

In addition, researchers and state health officials have determined that intermittent contaminated produce from a single carton or cartons going through a pre-cooling process may result over time in the build-up of pathogens in the pre-cooling water supply; thus, exposing subsequent cartons of produce to contamination (Ref. x).

- As produce quality deteriorates, the possibility of microbial contamination and growth increase. The benefits of chilling to remove field heat and the temperature requirements for optimum keeping quality will vary for different types of produce.
- Growers should be aware of the water source used to make ice for chilling produce. Chilling water and water used to make ice should be safe and sanitary. The water should be tested periodically for microbial contaminants.
- Chilling equipment, such as hydrocoolers, and containers holding produce during chilling operations should be clean and sanitary.

III. MANURE AND MUNICIPAL SEWAGE SLUDGE

There is widespread and well established agreement among health officials and scientists that animal manure and human fecal matter represent a significant source of human pathogens. As an example, a particularly dangerous pathogen, *Escherichia coli* O157:H7 is known to originate primarily from ruminants such as cattle, sheep and deer, that shed it through their feces. In addition, animal and human fecal matter are known to harbor *Salmonella*, *Cryptosporidium*, and other pathogens of major concern. Thus, the use of manure or municipal sewage sludge in the production of fresh produce must be closely managed to limit the potential for pathogen contamination. Growers must also be alert to the presence of

human or animal fecal matter that may be unwittingly introduced into the produce growing and handling environments.

Municipal sewage sludge is not widely used on fields growing fresh produce. However, properly treated municipal sewage sludge has been shown to have beneficial agricultural uses. Further, much research has been done on treatments to reduce levels of pathogens in sludge. Some of the recommendations from these studies may be applicable to manure.

A. MICROBIAL HAZARD

Properly treated manure or municipal sewage sludge can be an effective and safe fertilizer. Untreated or improperly treated manure or sludge used as a fertilizer, used to improve soil structure, or that enters surface or ground waters through run off, may contain pathogens that can contaminate produce. Growers need to critically examine their specific growing environment to identify obvious sources of fecal matter that could be a source of contamination. Such sources may include: use of untreated or improperly treated manure; nearby composting, livestock, or poultry operations; nearby municipal wastewater or sludge storage, treatment, or disposal areas; or high concentrations of wildlife in the growing and harvesting environment (e.g., nesting birds in a packing shed or heavy concentrations of migratory birds or deer in fields).

B. CONTROL OF POTENTIAL HAZARDS

1.0 Municipal Sewage Sludge

On July 18, 1991, the Environmental Protection Agency (EPA) published a notice in the Federal Register outlining the U.S. policy statements on the beneficial use of municipal sewage sludge on Federal land, including its use on food crops. Requirements for the use of municipal sewage sludge are set out in Title 40 of the Code of Federal Regulations, part 503 (40 CFR part 503).

The use of municipal sewage sludge on fields used to produce food crops involves a number of concerns in addition to microbial risk factors (e.g., potential heavy metals and toxic organic compounds) that are beyond the scope of this document. The guide focuses on microbial hazards. Pathogen considerations are governed by the EPA part 503 rule and are set out in "Domestic Septage Regulatory Guidance - A Guide to the EPA 503 Rule," EPA 832-B-92-005, September, 1993. (See also US EPA, "A Plain English Guide to the EPA Part 503 Biosolids Rule," EPA 1832-R-93-003, Washington DC, 1994.)

Growers may obtain guidance on proper agronomic methods from USDA's Natural Resource Conservation Service (NRCS) (formerly the Soil Conservation Service), and Cooperative State Research, Education, and Extension Service. Additional technical information on the use of sludge or manure in crop production, including fruits and vegetables, is available in publications from EPA and USDA.

2.0 Manure

Growers may need to develop and follow good agricultural practices for handling manure as a key to reducing the potential of introducing microbial hazards to produce. Such practices may include processes, such as composting, that are designed to reduce possible levels of pathogens in manure. Good agricultural practices may also include minimizing, to the extent feasible, direct or indirect manure-to-produce contact, especially close to harvest.

Examples of microbial hazards for growers to consider in assessing the use of manure in their operations, and recommendations for good agricultural practices to avoid or reduce food safety risk are discussed below.

2.1 Treatments to Reduce Pathogen Levels

A variety of treatments may be used to reduce pathogens in manure and other organic materials. Treatments may be divided into two groups, passive and active. Passive treatments rely on environmental factors, such as natural temperature and moisture fluctuations and UV irradiation to reduce pathogens. If manure is applied to fields, competition with soil microorganisms may also reduce pathogens. Active treatments include pasteurization, heat drying, anaerobic digestion, alkali stabilization, aerobic digestion, or combinations of these. Treatment may be performed by the grower using organic materials generated on the farm or by a third party (e.g., supplier). Choice of treatment will depend on the needs and resources of an individual grower or supplier.

2.1.1 Composting

Composting refers to a managed process in which organic materials are digested aerobically or anaerobically by microbial action. Properly composted manure can be an effective and safe fertilizer and/or soil amendment. The heat generated in the composting process can kill many microorganisms present due to the high temperature generated. Most compost is mixed and reaerated to extend the composting cycle or to create a secondary stage of composting.

Historically, much of the research on the composting of manure and application of manure to field crops has focused on the effects of different practices on soil fertility and crop quality. Research on pathogen survival in untreated manure, treatments to reduce pathogen levels in manure, and assessing the risk of cross-contamination of food crops from manure under varying conditions is largely just beginning. In addition, the time and temperature required to eliminate or reduce microbial hazards in manure or other organic materials may vary depending on the specific management practices of an individual operation.

On the other hand, much research has been done to assess the risk of microbial contamination from sewage sludge and on how to reduce potential hazards. For example, EPA recommends composting processes for municipal waste water sludge that achieve a temperature of 131 to 149 degrees F (55 - 60 degrees C) for a period of at least three days (Ref X).

EPA requirements for municipal sewage sludge are set out in 40 CFR part 503. Growers may want to refer to this document and, where applicable, consider following similar practices when composting manures. It should be noted however, that some pathogens have a higher thermal threshold than others. For example, the Hepatitis A virus is not destroyed until temperatures reach approximately 80 degrees C (ref x). While the agencies do not have sufficient data to make specific time and temperature recommendations that would apply to all composting or other manure treatment operations, good agricultural practices, as discussed below, may reduce the risk of microbial cross-contamination from manure to fresh produce.

2.2 Handling and Application

Practices that minimize cross-contamination from manure in open fields, compost piles, or storage areas onto nearby maturing crops will decrease the opportunities for contamination. Good agricultural practices for handling untreated or incompletely treated manure might include:

- securing the manure or compost to prevent cross-contamination from run off, leaching, or wind spread;
- cleaning equipment, such as tractors, that come into contact with untreated or partially treated manure before the equipment comes into contact with produce;
- scheduling manure application on adjacent fields to maximize the time between application to those fields and harvest of fresh market produce; and
- establishing field plans where the fields closest to fresh produce crops are planted to crops that do not receive manure.

2.2.1 Untreated Manure

Composting manure and other treatments may reduce the level of bacterial and other pathogens in manure. Use of untreated manure on food crops may carry a greater risk of contamination compared to the use of manure that has been treated to reduce pathogens. Growers using untreated manure may need to consider the following good agricultural practices:

- Growers may reduce the risk of contamination from manure by maximizing the time between application of manure to a field and harvest. According to the National Organic Standards Board, formed under the Organic Food Production Act of 1990, untreated manure should not be applied within 60 days of harvest. Minimum recommended intervals for specific crops may be longer, e.g. 120 to 150 days between application and harvest for stone fruit (ref x).
- Some researchers have found that *E. coli* O157:H7 may survive in dairy cattle manure for at least 70 days, depending on temperature and, perhaps, available moisture (ref X). Other researchers have found that *E. coli* O157:H7 may survive in sheep manure for more than a year (ref x). Thus, growers using untreated manure may want to choose longer, rather than shorter, intervals between application and harvest.
- To the extent feasible, growers should consider incorporating manure into the soil prior to planting. Growers may also consider maximizing the time between manure application and harvest of produce for the fresh market by planning crop rotations where manure is applied to fields planted to crops that are to be cooked or properly heat processed prior to being delivered to consumers.

2.2.2 Treated Manure

Natural fertilizers such as composted manure need to be produced in a manner to reduce the likelihood of introducing microbial hazards. Care should be taken to avoid cross-contamination of fresh produce from manure that is in the process of being composted or otherwise treated. Growers purchasing manure that has been composted or otherwise treated may want to request that the supplier provide documentation or other assurances as to the microbial quality of the manure. Growers using treated manure may need to consider the following good agricultural practices:

- Composting and other treatments may reduce but might not eliminate pathogens in manure. Furthermore, it is unknown to what extent pathogens that survive treatment may regrow in composted manure that is stored before use. Therefore, to the extent feasible, growers using

treated manure may want to consider some of the recommendations made for untreated manure, such as maximizing time between application and harvest.

- The specific requirements of any treatment to reduce pathogens will depend on many factors, including: types of organic materials being treated, pH, moisture content, process management, the carbon/nitrogen balance of the organic materials, and even climatic factors such as rainfall and temperature. Whatever parameters are selected, operators may need to apply good agricultural practices that ensure that all materials receive an adequate treatment, such as turning outside edges into the center of a compost pile or bin.
- The NRCS Conservation Practice Standard 317, "Composting Facility" sets out standards for on-farm composting (USDA, SCS, December 1990). (See also NRCS AWMFH 651.1004(F), Rynk et al., "On Farm Composting Handbook," NRAES-54 North Regional Agricultural Engineering Svc, Cooperative Extension, and R.T. Haug, 1993, "The Practical Handbook of Compost Engineering," Tachnomics Publishing Co., Inc, Lancaster, PA.)
- As more data become available on the viability of microorganisms in manure, and on treatments that most effectively reduce microbial hazards, growers may need to take note of any recommendations and adjust practices accordingly.

3.0 Animal Feces

Growers should assess the prevalence and likelihood of significant amounts of uncontrolled deposits of animal feces coming into contact with crops. Good agricultural practices for minimizing hazards include:

- Domestic animals, such as cows or sheep, should not be allowed to come into contact with crops. Depending on the operation, good management practices may include keeping livestock confined (e.g., in pens or yards) or preventing their entry into fields using physical barriers (e.g., fences).
- Growers should determine whether surrounding farms are used for animal husbandry. Measures to ensure that animal waste from adjacent fields or waste storage facilities will not cross-contaminate the crop during heavy rains. Measures might include physical barriers, such as ditches and mounds.
- To the extent possible, operators should assess wild animal populations. High concentrations of wildlife (e.g., deer or waterfowl in a field) may increase the potential for microbial contamination. Growers may be able to establish good agricultural practices which effectively deter or redirect wildlife to crop areas that are not destined for the fresh produce market. Options include visual, auditory, or physical deterrents and border crops or buffer areas between fields growing fresh market produce and areas frequented by wildlife.

IV. SANITATION AND HYGIENE

Illnesses associated with fresh fruits and vegetables are primarily those transmitted by the fecal-oral route. Although raw produce can serve as a source of a variety of foodborne organisms, such as viruses, bacteria, protozoa, fungi, and parasitic worms, one of the greatest concerns is associated with the presence of pathogenic bacteria, such as *E. coli* 0157:H7. Methods directed towards reducing food safety risks in fresh produce production, harvesting and distribution operations must start with good sanitation and hygiene practices. In this guide, the application of a good sanitation and hygiene program will focus on the employee, environment, facilities, and transportation of fresh produce.

A. WORKER

The U.S. Code of Federal Regulations Title 21, Section 110.10 (21 CFR 110.10) prescribes worker hygiene and sanitation practices within the context of GMPs in the manufacturing, packing, or holding human food (Appendix A). The standards established in this section should be considered when establishing hygiene and sanitation practices in the agricultural environment.

1.0 Microbial Hazard

Worker health and hygiene play a critical role in the controls for minimizing microbial contamination of fresh produce. Fecal-oral diseases are the primary microbiological concern that have been associated with fresh produce. These diseases can be spread by workers during growing, harvesting, sorting, processing, and packing fresh produce. Infected food workers/employees have been implicated as the source of several foodborne outbreaks of gastroenteritis, involving salads, cold food items, and ice (13). Proper handwashing minimizes the spread of pathogenic bacteria and other microbial hazards, limiting the potential for contamination of produce due to human handling.

2.0 Control of Potential Hazards

2.1 Personal Health

Good hygienic practices by all personnel who are involved in the harvesting, packing, and distribution of fresh produce are essential in the control of microbial and other biological hazards. Any individual in the agricultural environment (farm, packing areas, and transportation chain) who contacts fresh produce or equipment used in contact with fresh produce in agricultural areas presents a potential contamination risk. It is important to ensure that all personnel, including those indirectly involved in fresh produce operations (such as, pest control operators), comply with established hygienic practices.

Infectious diseases, ill health accompanied by diarrhea, open lesions (including boils, sores, or infected wounds), and other ailments are a source of microbial contamination that could contaminate fresh produce, water supplies, and other workers. Some microbial pathogens that can be transmitted by food contaminated by infected individuals includes, but is not limited to, the following: *Salmonella* species, *Shigella* species, *Staphylococcus aureus*, *Streptococcus pyrogenes*, *E. coli*, *Giardia lamblia*, and hepatitis A virus. Symptoms associated with infections by these pathogens may include diarrhea, fever, vomiting, jaundice, and sore throat with fever. An employee suffering from any of these symptoms presents an increased risk of transmitting foodborne illness.

It is suggested that:

- Operators train employees to report to the person in charge any information about their health or activities as they relate to diseases that are transmissible through food. Because of the high infectivity (ability to invade and multiply) and virulence (ability to produce severe disease) of *Salmonella typhi*, *Shigella* species, *E. coli* 0157:H7, or hepatitis A virus, any worker diagnosed with an active case of illness caused by any of these pathogens should be restricted from work assignments that involves contact with fresh produce or produce handling equipment.
- The supervisor, or the person in charge, should consider ways to monitor the health of their employees and take steps to reduce the chance of foodborne illness. For example, disposable

rubber or similar gloves, leak-proof band aids, or other corrective measures for minor cuts should be provided for use as necessary by personnel who may have contact with produce. More importantly, the person in charge should be sure that workers with diarrheal disease are not working with fresh produce or any equipment used in the harvesting and processing of fresh produce.

- Workers should be taught to report symptoms caused by illness, infection, or other source that is associated with:
 - acute gastrointestinal illness such as: diarrhea, fever, vomiting, jaundice, or sore throat with fever.
 - a lesion containing pus such as a boil or infected wound that is open or draining and that is located on parts of the body that might have contact with produce or produce harvesting equipment.

2.2 Training

All employees, including supervisors, full time, part time and seasonal personnel, should be trained in good hygienic practices. Operators or growers may want to consider establishing a training program that would include a system to monitor and evaluate compliance with established sanitary practices. The operators should also consider follow up training sessions to encourage adherence to good hygienic practices. The focus of any training program should include, but is not limited to, the following:

- The importance of good hygiene. All personnel should understand the impact of poor personal cleanliness and unsanitary practices on food safety.
 - Smoking or eating in areas where fresh produce is present can contaminate the produce because of the potential that the hands and food-contact surfaces may become contaminated.
 - Insanitary personal practices such as scratching the head, placing the fingers in or about the mouth or nose, and indiscriminate and uncovered sneezing or coughing may contaminate fresh produce or any handling equipment.
 - Within packinghouses, hair can be a direct and indirect vehicle of produce contamination. Workers may contaminate their hands by touching their hair. For enclosed facilities, operators may want to consider the use of hair restraints to keep dislodged hair from ending up in fresh produce and to deter employees from touching their hair.
- The importance of handwashing. Thorough handwashing after each absence from the work station, after using the bathroom, before and after eating, and before commencing work is very important. Many of the diseases that are transmissible through food may be harbored in the employee's intestinal tract and shed in the feces. Thorough washing of hands with soap and warm water helps to stop the spread of germs. Employees should be taught proper handwashing techniques, that include:
 - hand washing with warm water (if available);
 - proper use of soap; and

- thorough scrubbing (including cleaning under finger nails and between fingers), rinsing, and drying of the hands.
- The importance of using sanitation facilities. All employees should be encouraged to use on-site latrines and to avoid eliminating wastes outside of these facilities. The use of well maintained sanitation facilities for waste elimination helps reduce the potential for cross contaminating fields, produce, other workers, and water supplies, and increases the likelihood that employees will wash their hands after using such facilities. See section B.2. (field) or C.2. (facility) for additional information about toilet facilities.

B. FIELD

1.0 Microbial Hazards

Microbial contamination or cross-contamination of produce during pre-harvest and harvest activities may result from contact with soils, fertilizers, water, workers, and growing and harvesting equipment. Any of these may be a source of pathogenic microorganisms. Sections II. and III. in this guidance document address the concerns associated with water quality and use of manure and municipal wastewater sludges, and section IV.A. above addresses the importance of worker hygiene.

Operations with poor management of human and other wastes in the field can significantly increase the risk of contaminating produce. Pathogenic microorganisms may be found in soil or water and on the surfaces of any equipment used to harvest produce in the field. Good sanitation practices should be employed throughout the environment and handling processes.

2.0 Control of Potential Hazards

Operators should become familiar with laws and regulations (local, state, regional, or national) that describe appropriate field sanitation practices. Field sanitation laws generally outline the appropriate number of restrooms to the number of workers, the maximum worker-to-restroom distance, and how often such facilities should be cleaned.

2.1 Toilet Facilities

- Operators should consider the importance of proximity and accessibility of toilet facilities to harvest crews in all sectors of fresh produce production. The more accessible the facilities, the greater the likelihood that they will be used. Workers should always have the opportunity to use the facilities when they need to, not only when they are on break. This will help reduce the incidence of workers relieving themselves elsewhere (such as in fields).
- Growers need to assure that the location where workers use a facility, if in the field, is not near a water source used in irrigation; or in a location that would subject it to potential runoff in the event of heavy rains.
- Toilet facilities should be provided to all employees.
- Toilet facilities, including portable toilets, need to provide adequate handwashing stations with water (including warm water if possible) that is suitable for handwashing or drinking.

- Toilet facilities should be well supplied. Adequate supplies of toilet paper, sanitary hand drying devices (such as single-use paper towel dispensers), and soap are desirable.
- Toilet facilities should be maintained in sanitary condition and good repair at all times.

2.2 Sewage Disposal

Improper disposal of human waste from toilets could lead to water, soil, animal, or crop contamination. Systems and practices should be in place to insure safe management and disposal of waste from permanently installed and portable toilets to prevent drainage into the field. Operators should follow EPA regulations for the use or disposal of sewage sludge, 40 CFR Part 503, or refer to EPA's "Domestic Septage Regulatory Guidance: A Guide to the EPA Part 503 Rule" (Ref.). Examples of good practices to consider are as follows:

- Clean or service portable toilets away from the field, if possible. Waste water from portable or permanent toilet facilities that drain into field can contaminate produce. Dispose of wastes through a sub-surface septic tank system, drain waste water away from field, or collect waste water in a drainage tank to be correctly disposed of at a remote site.
- Septic trucks servicing portable toilets should have direct access to the toilets. Where possible, toilets should be located in areas (such as downhill from the fields) to minimize the likelihood of contamination of produce in the event of leakage or a spill.
- Consider procedures for containment and treatment of any effluent from a portable toilet in the event of leakage or a spill. Operators should be made aware of any incidence of leakage or spillage of effluent in a field. Refer to 40 CFR Part 503 for additional guidance.

2.3 Harvesting Precautions

- Harvest crews should remove as much dirt and mud as possible from the produce before it leaves the field.
- Damaged or muddy cartons should be repaired, cleaned, or discarded in an effort to reduce possible microbial contamination of fresh produce.
- Care should be taken to ensure that produce that is harvested, washed, cooled, and packaged in the field is not contaminated in the process. Contact with manure, or other fertilizers, poor quality water in hydrocoolers, workers with poor hygiene, and unclean packaging or packing boxes greatly increase the risk of contamination of product with pathogenic organisms.
- Growers may recommend that product inspectors, buyers, and other visitors thoroughly wash their hands and/or wear clean disposable gloves when inspecting produce.

2.4 Equipment Maintenance

Field equipment can easily spread germs to fresh produce. 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.

- Consider assigning responsibility of maintaining equipment sanitation to the person in charge of field workers and the day to day activities in the field. The person in charge should be aware of how equipment is being used during the day and take steps to ensure proper cleaning of equipment where needed.
- Keep harvesting and any processing equipment, such as harvesting machinery, cartons, tables, baskets, packaging materials, brushes, buckets, etc., as clean as practicable.
- Personnel should not use harvesting containers for carrying materials (such as, lunches, tools, fuels, etc.) other than harvested product.
- Remove contaminants, such as mud, diesel, grease, oil, produce, debris, from harvesting and processing equipment daily.

2.5 Animal Control

Growers should assess the prevalence and likelihood of uncontrolled animal access to fields in order to reduce the potential for contamination of crops by fecal material. See section III.B.3. in this guidance document for more information on control of potential hazards associated with animal feces.

C. Facility

It is important to maintain buildings, plants, fixtures, and other physical facilities, and their grounds, in sanitary condition to reduce the potential for microbial contamination of produce.

1.0 Microbial Hazard

Anything that comes in contact with the food has the potential for being a source of pathogenic microorganisms. Operations with poor sanitation in the packinghouse environment can significantly increase the risk of contaminating fresh produce and water. Pathogenic microorganisms may be found on the floors, walls, ceilings, and drains in the packinghouse and on the surfaces of processing equipment. In the absence of good sanitary practices, any of these surfaces that come in contact with food could be a potential source of microbial contamination. Good sanitation practices should be employed throughout the processing environment and include routine scrutiny of produce contact surfaces.

2.0 Control of Potential Hazards

Operators should become familiar with laws and regulations (such as, local, state, regional, or national) that describe appropriate facility sanitation practices. The U.S. Code of Federal Regulations prescribes current good manufacturing practices for buildings and facilities, equipment, and production and process controls (21 CFR 110.20 to 110.93), and is a good resource to guide the development of mitigation programs (Appendix A).

2.1 Toilet Facilities

- Toilet facilities should be provided for all employees.
- Toilet facilities should be located within an easy walking distance to the workers.

- Toilet facilities, whether permanent or portable, should provide adequate handwashing stations with water suitable for handwashing and drinking. If possible, provide warm water for handwashing.
- Toilet facilities should be well supplied. A well-supplied facility provides adequate toilet paper, sanitary hand drying devices (such as single-use paper towel dispensers), and soap.
- Toilet facilities should always be maintained in a sanitary condition and good repair at all times.

2.2 Sewage Disposal

For packinghouses that use permanent or portable toilets, care should be taken to ensure proper disposal of human waste. Systems and practices should be in place to insure safe management and disposal of waste from toilets to prevent drainage into the field or water supplies. Operators should follow EPA standards for the use or disposal of sewage sludge, 40 CFR Part 503, or refer to EPA's "Domestic Septage Regulatory Guidance: A Guide to the EPA Part 503 Rule" (Ref.). Examples of good practices to consider are as follows:

- Waste water from toilet facilities that drain into a field can contaminate produce. Therefore, it is important to try to dispose of wastes through a sub-surface septic tank system, drain waste water away from fields, or collect waste water in a drainage tank to be correctly disposed of at a remote site.
- Septic trucks servicing the portable toilets should have direct access to the toilets.
- Toilets should be located in areas (such as downhill from the field) to minimize the likelihood of contamination of the field or water supplies in the event of leakage or a spill. Consider procedures for containment and treatment of any effluent in the event of leakage or a spill and be aware of any incidence of leakage or spillage in a field.

2.3 Processing Precautions

- Damaged or muddy cartons should be repaired, cleaned, or discarded in an effort to reduce possible microbial contamination of fresh produce.
- Operators might set aside an area in the receiving yard for treatment of pallets and containers. Pallets should be clean, and cartons should be clean and sanitary before using in contact with fresh produce.
- It is recommended that product inspectors, buyers, and other visitors thoroughly wash their hands and/or wear clean disposable gloves when handling produce.

2.4 Equipment Maintenance

Equipment and utensils should be of such material and workmanship as to be adequately cleanable. The design, construction, use, and general cleanliness of equipment and utensils can help reduce the risk of cross contamination of produce. Operators or growers might consider:

- Removal of contaminants, such as mud, diesel, grease, oil, produce, and debris from processing equipment daily.
- Repairing, cleaning (as practicable), or discarding damaged and muddy cartons or boxes to reduce contamination of produce.
- Keeping equipment or machinery that comes in contact with fresh produce as clean as practicable. Equipment such as knives, saws, blades, boots, gloves, smocks, and aprons should be cleaned, inspected for defects on a regular basis, and replaced as needed.
- To reduce potential for cross-contamination of equipment, personnel should not use packinghouse equipment or machinery that has contact with fresh produce for carrying other materials (for example, lunches, tools, fuels, etc.).
- Keeping packinghouse and cooling facilities clean and sanitary to reduce the potential for microbial contamination.
- Maintaining, as needed, the cooling system to ensure proper functioning of the equipment. Consider inspecting all pre-cooling equipment daily, removing all debris, and cleaning as necessary.
- Regular cleaning of product storage and processing areas. Clean and remove all visible debris, soil, and dirt on an ongoing basis. Free floating dust and dirt from within the facility should be kept to a minimum.

2.5 Pest Control

All animals, including mammals, birds, reptiles, and insects, are potential sources of contamination in agricultural environments because they may harbor, or be a vector for, a variety of pathogenic agents, such as *Salmonella*. For enclosed facilities, a pest control program is essential for reducing the risk of contamination by rodents and other animals. Packing, storage, and processing facilities, and the grounds around such facilities, should be kept in a condition to protect them from pest contamination inside the facilities. Pest problems can be minimized by taking a few precautions, such as:

- Proper storage of equipment. All enclosed facilities and grounds in the immediate vicinity should be kept clear of waste and litter, and all grasses be kept cut to discourage the breeding and harboring of pests, such as rodents and reptiles. Remove any unnecessary articles, including equipment that is no longer used, to rid of areas where rodents and insects can harbor.
- Maintain adequate surface drainage to reduce breeding places for pests.
- Clean daily to remove product or product remnants that attract pests in and around the packinghouse and any other facility where product is handled or stored.
- Regularly inspect all facilities to check for evidence of pest populations or animal contamination. Try to minimize the availability of food and water to pests.
- Remove dead or trapped birds, insects, rodents, and other pests promptly to ensure clean and sanitary facilities and to preclude exacerbating the situation by allowing carcasses to attract other pests.

- Ensure that all potential nesting or hiding places for pests have been eliminated. Try to exclude pests by blocking areas, such as holes in walls, doors, flooring, etc., and vents that allow entrance into the facility. Consider the use of traps as needed.
- Maintain a pest control log to include dates of inspection, inspection report, and steps taken to eliminate any problems. A pest control program should also include frequent re-inspection of affected and treated areas to determine the effectiveness of the treatment applied.

D. Transportation

Growers are encouraged to pay particular attention to the product as it leaves the field for the cooler, packing shed, or processing facility. Contamination of produce may occur due to improper practices during loading, unloading, and transportation operations. Wherever product is transported and handled, the sanitation conditions should be evaluated, especially between links in the distribution chain. The proper transporting of fresh fruits and vegetables will help reduce the potential for microbial contamination. The U.S. Code of Federal Regulations states that "storage and transportation of finished food shall be under conditions that will protect food against physical, chemical, and microbial contamination" (21 CFR 110.93, Appendix A).

1.0 Microbial Hazard

Cross-contamination from other foods and nonfood sources and contaminated surfaces may occur during transport. Fresh produce should be segregated from other food and nonfood sources of pathogens in order to prevent contamination of the produce.

2.0 Control of Potential Hazards

2.1 Packing Precautions

- Workers involved in the loading and unloading of product during transport should practice good hygiene (e.g., proper hand washing). See section IV.A.2. for more information about good hygienic practices.
- Product transport equipment, such as conveyors and pallets, should be free of obvious contaminants (mud, oil, produce debris, etc).
- It is recommended that product inspectors, buyers, and other visitors thoroughly wash their hands and/or wear clean disposable gloves when inspecting produce.

2.2 Transport Precautions

Operators should try to assure that sanitation requirements for trucks or other carriers are met before loading to help reduce the likelihood for microbial contamination. An active and ongoing discussion with personnel responsible for transportation is essential for assuring the success of any safety management program. Without a dialogue on food safety risks and the need for adequate sanitation standards at each step along the farm to table pathway, any safety steps implemented by growers and packers may be negated. Communication along the transportation chain by all industry segments is paramount to delivering safe foods to the consumer. Some specifics to consider:

- Keep transportation vehicles clean to help reduce the risk of microbial contamination or cross-contamination of fresh produce. For example, trucks that were recently used to transport garbage would have a relatively high potential for being a source of microbial hazard.
- Inspect trucks or transport cartons before loading produce.
- Maintain proper storage temperatures to help ensure both the quality and safety of fresh produce.
- All fresh produce should be carefully loaded in trucks in a manner designed to minimize physical damage to the produce and to reduce the potential for contamination during transport.

V. POSITIVE LOT IDENTIFICATION

Despite the best of efforts by food industry operators, food will never be completely free of microbial hazards. Consequently, the ability to identify the source of a product (i.e., positive lot identification) can serve as an important complement to good management practices intended to prevent the occurrence of food safety problems. A system to identify the source of fresh product cannot prevent the occurrence of a microbiological hazard which may lead to an outbreak of foodborne disease. However, an effective positive lot identification system can limit the potential scope of an outbreak associated with produce originating from a single shipper. 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. From a public health perspective, besides limiting the population at risk in an outbreak, positive lot identification can minimize the unnecessary expenditure of valuable public health resources, reduce consumer anxiety, and free consumers to enjoy a vast array of fresh fruits and vegetables not implicated in an outbreak.

Because of the diversity of handling practices throughout the produce distribution chain, a positive lot identification system may be more easily implemented for some commodities than others. However, the agencies support the concept of lot identification and encourage industry associations and operators to consider ways to provide this capability where feasible. Operators should examine current company procedure and develop procedures to track individual containers from the farm, to the cooler, to the receiver, in as much detail as possible. Shippers should strive to develop technology to provide more detailed and rapid lot identification capabilities. At a minimum, an effective positive 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.

Documentation should include:

- a. Date of harvest,
- b. Farm identification, and
- c. Chain of custody from cooler to receiver.

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