CODE OF HYGIENIC PRACTICE FOR FRESH FRUITS AND VEGETABLES

CAC/RCP 53-2003

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INTRODUCTION

Scientific research over the last decades has shown that a diet rich in fruits and vegetables is protective against many cancers and lowers the occurrence of coronary heart disease. This recognition of the importance of routine consumption of fresh fruits and vegetables, together with a marked increase in the year-round availability of fresh fruits and vegetables from a global market, has contributed to the substantial increase in consumption of fresh fruits and vegetables over the past two decades. However, the recent increase in reports of food borne illness associated with fresh fruits and vegetables has raised concerns from public health agencies and consumers about the safety of these products.

1. OBJECTIVES OF THE CODE

This code addresses Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) that will help control microbial, chemical and physical hazards associated with all stages of the production of fresh fruits and vegetables from primary production to packing. Particular attention is given to minimizing microbial hazards. The code provides a general framework of recommendations to allow uniform adoption by this sector rather than providing detailed recommendations for specific agricultural practices, operations or commodities. The fresh fruit and vegetable industry is very complex. Fresh fruits and vegetables are produced and packed under diverse environmental conditions. It is recognized that some of the provisions in this code may be difficult to implement in areas where primary production is conducted in small holdings, in both developed and developing countries and also in areas where traditional farming is practised. Therefore, the code is, of necessity, a flexible one to allow for different systems of control and prevention of contamination for different groups of commodities.

2. SCOPE, USE AND DEFINITIONS

2.1 SCOPE

This code of practice covers general hygienic practices for the primary production and packing of fresh fruits and vegetables cultivated for human consumption in order to produce a safe and wholesome product: particularly for those intended to be consumed raw. Specifically, this code is applicable to fresh fruits and vegetables grown in the field (with or without cover) or in protected facilities (hydroponic systems, greenhouses). It concentrates on microbial hazards and addresses physical and chemical hazards only in so far as these relate to GAPs and GMPs.

The *Annexes for Ready-to-Eat Fresh Pre-cut Fruits and Vegetables* (Annex I), *Sprout Production* (Annex II), *Fresh Leafy Vegetables* (Annex III), *Melons* (Annex IV) and *Berries* (Annex V) are supplements to this code and include additional recommendations to cover, respectively, the hygienic practices for the these commodities.

The code does not provide recommendations for handling practices to maintain the safety of fresh fruits and vegetables at wholesale, retail, food services or in the home. It excludes food products for which there is a specific Codex Alimentarius Code of Hygienic Practices.

2.2 USE

This code follows the format of the *General Principles of Food Hygiene* – CAC/RCP 1-1969 and should be used in conjunction with it. This code focuses upon hygienic issues that are specific to the primary production and packing of fresh fruits and vegetables. The major issues are covered in Section 3. In other sections, the *General Principles of Food Hygiene* have been expanded where there are issues specific to primary production and packing. The *Annex for Ready-to-Eat Fresh Pre-Cut Fruits and Vegetables* provides additional recommendations specific for the processing of ready-to-eat fresh pre-cut fruits and vegetables, the *Annex for Sprout Production* provides additional recommendations specific for the primary production of seeds for sprouting and the production of sprouts for human consumption, the *Annex for Fresh Leafy Vegetables* provides specific guidance related to the production, harvesting, packing, processing, storage, distribution, marketing and consumer use of fresh leafy vegetables that are intended to be consumed without further microbiocidal steps, the *Annex for Melons* provides specific guidance on how to minimize microbiological hazards during primary production through packing and transport of fresh melons, including fresh melons processed for the pre-cut market and consumer use and the *Annex for Berries* provides additional recommendations for the production, packing and distribution of fresh berries, as well as fresh berries that are processed without a microbiocidal step.

2.3 DEFINITIONS

Definitions of general expressions are included in the *General Principles of Food Hygiene*. For the purpose of this code, the following terms have the definition stated:

Agricultural inputs – any incoming material (e.g. seeds, fertilizers, water, agricultural chemicals, plant support, etc.) used for the primary production of fresh fruits and vegetables.

Agricultural worker – any person that undertakes one or more of the following: cultivation, harvesting and packing of fresh fruits and vegetables.

Antimicrobial agents – any substance of natural, synthetic or semi-synthetic origin which at low concentrations kills or inhibits the growth of micro-organisms but causes little or no host damage.

Biological control – the use of competing biologicals (such as insects, micro-organisms and/or microbial metabolites) for the control of mites, pests, plant pathogens and spoilage organisms.

Biosolids – Sludge and other residue deposits obtained from sewage treatment plants and from treatment applied to urban and industrial wastes (food industries or other types of industry).

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

Cultivation – any agricultural action or practise used by growers to allow and improve the growing conditions of fresh fruits or vegetables grown in the field (with of without cover) or in protected facilities (hydroponic systems, greenhouses).

Farm – any premise or establishment in which fresh fruits and/or vegetables are grown and harvested and the surroundings under the control of the same management.

Grower – the person responsible for the management of the primary production of fresh fruits and vegetables.

Harvester – the person responsible for the management of the harvesting of fresh fruits and vegetables.

Hazard – a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Hazardous material – any compound which, at specific levels, has the potential to cause adverse health effects.

Hydroponics – a general term for the production of plants without soil in a water medium.

Manure – Animal excrement which may be mixed with litter or other material, and which may be fermented or otherwise treated.

Micro-organisms – include yeasts, moulds, bacteria, viruses and parasites. When used as an adjective, the term “microbial” is used.

Packer – the person responsible for the management of post-harvest processing and packing of fresh fruits and vegetables.

Packing – the action of putting fresh fruits and vegetables in a package. This may take place in a field or in an establishment.

Packing establishment – any indoor establishment in which fresh fruits and vegetables receive post-harvest treatment and are packaged.

Primary production – those steps involved in the growing and harvesting of fresh fruits and vegetables such as planting, irrigation, application of fertilizers, application of agricultural chemicals, etc.

Types of water:

Clean water – water that does not compromise food safety in the circumstances of its use.

Potable water – water which meets the quality standards of drinking water such as described in the WHO Guidelines for Drinking Water Quality.

3. PRIMARY PRODUCTION

Fresh fruits and vegetables are grown and harvested under a wide range of climatic and diverse geographical conditions, using various agricultural inputs and technologies, and on farms of varying sizes. Biological, chemical and physical hazards may therefore vary significantly from one type of production to another. In each primary production area, it is necessary to consider the particular agricultural practices that promote the production of safe fresh fruits and vegetables, taking into account the conditions specific to the primary production area, type of products, and methods used. Procedures associated with primary production should be conducted under good hygienic conditions and should minimize potential hazards to health due to the contamination of fresh fruits and vegetables.

3.1 ENVIRONMENTAL HYGIENE

Where possible, potential sources of contamination from the environment should be identified. In particular, primary production should not be carried out in areas where the presence of potentially harmful substances would lead to an unacceptable level of such substances in or on fresh fruits and vegetables after harvest.

Where possible, growers should evaluate the previous uses of the sites (indoor and outdoor) as well as adjoining sites in order to identify potential microbial, chemical and physical hazards. The potential for other types of contamination (e.g., from agricultural chemicals, hazardous wastes, etc.) should also be considered. The evaluation process should include the following:

- Previous and present usage of the primary production area and the adjoining sites (e.g. crop grown, feed lot, animal production, hazardous waste site, sewage treatment site, mining extraction site) to identify

potential microbial hazards including faecal contamination and contamination by organic waste and potential environmental hazards that could be carried to the growing site.

- The access of farm and wild animals to the site and to water sources used in primary production to identify potential faecal contamination of the soils and water and the likelihood of contaminating crop. Existing practices should be reviewed to assess the prevalence and likelihood of uncontrolled deposits of animal faeces coming into contact with crops. Considering this potential source of contamination, efforts should be made to protect fresh produce growing areas from animals. As far as possible, domestic and wild animal should be excluded from the area.
- Potential for contaminating produce fields from leaking, leaching or overflowing manure storage sites and flooding from polluted surface waters.

If previous uses cannot be identified, or the examination of the growing or adjoining sites leads to the conclusion that potential hazards exist, the sites should be analysed for contaminants of concern. If the contaminants are at excessive levels and corrective or preventative actions have not been taken to minimize potential hazards, the sites should not be used until correction/control measures are applied.

3.2 HYGIENIC PRIMARY PRODUCTION OF FRESH FRUITS AND VEGETABLES

3.2.1 Agricultural input requirements

Agricultural inputs should not contain microbial or chemical contaminants (as defined under the *General Principles of Food Hygiene* (CAC/RCP 1-1969) at levels that may adversely affect the safety of fresh fruits and vegetables and taking into consideration the WHO guidelines on the safe use of wastewater and excreta in agriculture and aquaculture as appropriate.

3.2.1.1 Water for primary production

- Growers should identify the sources of water used on the farm (municipality, re-used irrigation water, well, open canal, reservoir, rivers, lakes, farm ponds etc.). They should assess its microbial and chemical quality, and its suitability for intended use, and identify corrective actions to prevent or minimize contamination (e.g. from livestock, sewage treatment, human habitation).
- Where necessary, growers should have the water they use tested for microbial and chemical contaminants. The frequency of testing will depend on the water source and the risks of environmental contamination including intermittent or temporary contamination (e.g. heavy rain, flooding, etc.). If the water source is found to be contaminated corrective actions should be taken to ensure that the water is suitable for its intended use.

3.2.1.1.1 Water for irrigation and harvesting

Water used for agricultural purposes should be of suitable quality for its intended use. Special attention to water quality should be considered for the following situations:

- Irrigation by water delivery techniques that expose the edible portion of fresh fruits and vegetables directly to water (e.g. sprayers) especially close to harvest time.
- Irrigation of fruits and vegetables that have physical characteristics such as leaves and rough surfaces which can trap water.
- Irrigation of fruits and vegetables that will receive little or no post-harvest wash treatments prior to packing, such as field-packed produce.

3.2.1.1.2 Water for fertilizers, pest control and other agricultural chemicals

Water used for the application of water-soluble fertilizers and agricultural chemicals in the field and indoors should not contain microbial contaminants at levels that may adversely affect the safety of fresh fruits and vegetables. Special attention to the water quality should be considered when using fertilizer and agricultural chemical delivery techniques (e.g. sprayers) that expose the edible portion of fresh fruits and vegetables directly to water especially close to harvest time.

3.2.1.1.3 Hydroponic water

Plants grown in hydroponic systems absorb nutrients and water at varying rates, constantly changing the composition of the re-circulated nutrient solution. Because of this:

- Water used in hydroponic culture should be changed frequently, or if recycled, should be treated to minimize microbial and chemical contamination.
- Water delivery systems should be maintained and cleaned, as appropriate, to prevent microbial contamination of water.

3.2.1.2 Manure, biosolids and other natural fertilizers

The use of manure, biosolids and other natural fertilizers in the production of fresh fruits and vegetables should be managed to limit the potential for microbial, chemical and physical contamination. Manure, biosolids and other natural fertilizers contaminated with heavy metals or other chemicals at levels that may affect the safety of fresh fruits and vegetables should not be used. Where necessary, in order to minimize microbial contamination the following practices should be considered:

- Adopt proper treatment procedures (e.g. composting, pasteurization, heat drying, UV irradiation, alkali digestion, sun drying or combinations of these) that are designed to reduce or eliminate pathogens in manure, biosolids and other natural fertilizers. The level of pathogen reduction achieved by different treatments should be taken into account when considering suitability for different applications.

- Manure, biosolids and other natural fertilizers which are untreated or partially treated may be used only if appropriate corrective actions are being adopted to reduce microbial contaminants such as maximizing the time between application and harvest of fresh fruits and vegetables.
- Growers who are purchasing manure, biosolids and other natural fertilizers that have been treated to reduce microbial or chemical contaminants, should, where possible, obtain documentation from the supplier that identifies the origin, treatment used, tests performed and the results thereof.
- Minimize direct or indirect contact between manure, biosolids and other natural fertilizers, and fresh fruits and vegetables, especially close to harvest.
- Minimize contamination by manure, biosolids and other natural fertilizers from adjoining fields. If the potential for contamination from the adjoining fields is identified, preventative actions (e.g. care during application and run-off controls) should be implemented to minimize the risk.
- Avoid locating treatment or storage sites in proximity to fresh fruit and vegetable production areas. Prevent cross-contamination from runoff or leaching by securing areas where manure, biosolids and other natural fertilizers are treated and stored.

3.2.1.3 Soil

Soils should be evaluated for hazards. If the evaluation concludes that such hazards are at levels that may compromise the safety of crops, control measures should be implemented to reduce hazards to acceptable levels. If this cannot be achieved by available control measures, growers should not use these soils for primary production.

3.2.1.4 Agricultural chemicals

- Growers should use only agricultural chemicals which are authorized for the cultivation of the specific fruit or vegetable and should use them according to the manufacturer's instructions for the intended purpose. Residues should not exceed levels as established by the Codex Alimentarius Commission.
- In order to minimize and contain the emergence of microbial resistance:
- the use of antimicrobial agents significant to human and animal therapy should be avoided.
- Antimicrobial agents not significant to human and animal therapy should be used only when unavoidable and in accordance with good agricultural practices and in a manner that achieves this objective.
- Agricultural workers who apply agricultural chemicals should be trained in proper application procedures.
- Growers should keep records of agricultural chemical applications. Records should include information on the date of application, the chemical used, the crop sprayed, the pest or disease against which it was used, the concentration, method and frequency of application, and records on harvesting to verify that the time between application and harvesting is appropriate.
- Agricultural chemical sprayers should be calibrated, as necessary, to control the accuracy of the rate of application.
- The mixing of agricultural chemicals should be carried out in such a way as to avoid contamination of water and land in the surrounding areas and to protect employees involved in this activity from potential hazards.
- Sprayers and mixing containers should be thoroughly washed after use, especially when used with different agricultural chemicals on different crops, to avoid contaminating fruits and vegetables.
- Agricultural chemicals should be kept in their original containers, labelled with the name of the chemical and the instructions for application. Agricultural chemicals should be stored in a safe, well ventilated place, away from production areas, living areas and harvested fruits or vegetables, and disposed of in a manner that does not pose a risk of contaminating crops, the inhabitants of the area, or the environment of the primary production.
- Empty containers should be disposed of as indicated by the manufacturer. They should not be used for other food-related purposes.

3.2.1.5 Biological control

Environmental and consumer safety should be considered when using competing biological organisms and/or their metabolites applied for the control of pests, mites, plant pathogens and spoilage organisms in fresh fruits and vegetables.

Growers should use only biological controls which are authorized for the cultivation of the specific fruit or vegetable and should use them according to the manufacturer's instructions for the intended purpose.

3.2.2 Indoor facilities associated with growing and harvesting

For operations where fresh fruits and vegetables are grown indoors (greenhouses, hydroponic culture, etc.) suitable premises should be used.

3.2.2.1 Location, design and layout

- Premises and structures should be located, designed and constructed to avoid contaminating fresh fruits and vegetables and harbouring pests such as insects, rodents and birds.
- Where appropriate, the internal design and layout should permit compliance with good hygienic practices for the primary production of fresh fruits and vegetables indoors, including protection against cross-contamination between and during operations. Each establishment should be evaluated individually in order to identify specific hygienic requirements for each product.

3.2.2.2 Water supply

Where appropriate an adequate supply of potable or clean water with appropriate facilities for its storage and distribution should be available in indoor primary production facilities. Non-potable water should have a separate system. Non-potable water systems should be identified and should not connect with, or allow reflux into, potable water systems.

- Avoid contaminating potable and clean water supplies by exposure to agricultural inputs used for growing fresh produce.
- Clean and disinfect potable and clean water storage facilities on a regular basis.
- Control the quality of the water supply.

3.2.2.3 Drainage and waste disposal

Adequate drainage and waste disposal systems and facilities should be provided. These systems should be designed and constructed so that the potential for contamination of fresh fruits and vegetables, agricultural inputs or the potable water supply is avoided.

3.2.3 Personnel health, hygiene and sanitary facilities

Hygiene and health requirements should be followed to ensure that personnel who come directly into contact with fresh fruits and vegetables during or after harvesting are not likely to contaminate them. Visitors should, where appropriate, wear protective clothing and adhere to the other personal hygiene provisions in this section.

3.2.3.1 Personnel hygiene and sanitary facilities

Hygienic and sanitary facilities should be available to ensure that an appropriate degree of personal hygiene can be maintained. As far as possible, such facilities should:

- Be located in close proximity to the fields and indoor premises, and in sufficient number to accommodate personnel.
- Be of appropriate design to ensure hygienic removal of wastes and avoid contamination of growing sites, fresh fruits and vegetables or agricultural inputs.
- Have adequate means of hygienically washing and drying hands.
- Be maintained under sanitary conditions and good repair.

3.2.3.2 Health status

People known, or suspected, to be suffering from, or to be a carrier of a disease or illness likely to be transmitted through fresh fruits and vegetables, should not be allowed to enter any food handling area if there is a likelihood of their contaminating fresh fruits and vegetables. Any person so affected should immediately report illness or symptoms of illness to the management.

3.2.3.3 Personal cleanliness

Agricultural workers who have direct contact with fresh fruits and vegetables should maintain a high degree of personal cleanliness and, where appropriate, wear suitable protective clothing and footwear. Cuts and wounds should be covered by suitable waterproof dressings when personnel are permitted to continue working.

Personnel should wash their hands when handling fresh fruits and vegetables or other material that comes in contact with them. Personnel should wash their hands before starting work involving the handling of fruits and vegetables, each time they return to handling areas after a break, immediately after using the toilet or after handling any contaminated material where this could result in contamination of fresh fruits and vegetables.

3.2.3.4 Personal behaviour

Agricultural workers should refrain from behaviour which could result in the contamination of food, for example: smoking, spitting, chewing gum or eating, or sneezing or coughing over unprotected fresh fruits and vegetables.

Personal effects such as jewellery, watches, or other items should not be worn or brought into fresh fruit and vegetable production areas if they pose a threat to the safety and suitability of the food.

3.2.4 Equipment associated with growing and harvesting

As required, growers and harvesters should follow the technical specifications recommended by the equipment manufacturers for their proper usage and maintenance. Growers and harvesters should adopt the following sanitary practices:

- Equipment and containers coming into contact with fresh fruits and vegetables should be made of materials that are non-toxic. They should be designed and constructed to ensure that, when necessary, they can be cleaned, disinfected and maintained to avoid the contamination of fresh fruit and vegetables. Specific hygienic and maintenance requirements should be identified for each piece of equipment that is used and the type of fruit or vegetable associated with it.
- Containers for waste, by-products and inedible or dangerous substances, should be specifically identifiable, suitably constructed and, where appropriate, made of impervious material. Where appropriate, such containers should be lockable to prevent malicious or accidental contamination of fresh fruits and vegetables or agricultural inputs. Such containers should be segregated or otherwise identified to prevent their use as harvesting containers.
- Containers that can no longer be kept in a hygienic condition should be discarded.
- Equipment and tools should function according to the use for which they are designed without damaging the produce. Such equipment should be maintained in good order.

3.3 HANDLING, STORAGE AND TRANSPORT

3.3.1 Prevention of cross-contamination

During the primary production and post-harvest activities, effective measures should be taken to prevent cross-contamination of fresh fruits and vegetables from agricultural inputs or personnel who come directly or indirectly into contact with fresh fruits and vegetables. To prevent the potential of cross-contaminating fresh fruits and vegetables, growers, harvesters and their employees should adhere to the recommendations presented elsewhere in section 3 of this code and the following:

- At the time of harvest, consideration should be given to the need for additional management action where any local factor, for example adverse weather conditions, may increase the opportunity for contamination of the crop.
- Fresh fruits and vegetables unfit for human consumption should be segregated during harvesting. Those which cannot be made safe by further processing should be disposed of properly to avoid contamination of fresh fruits and vegetables or agricultural inputs.
- Agricultural workers should not use harvesting containers for carrying materials (e.g. lunches, tools, fuel, etc.) other than harvested fruits and vegetables.
- Equipment and containers previously used for potentially hazardous materials (e.g. garbage, manure, etc.) should not be used for holding fresh fruits or vegetables or have contact with packaging material that is used for fresh fruits and vegetables without adequate cleaning and disinfecting.
- Care must be taken when packing fresh fruits and vegetables in the field to avoid contaminating containers or bins by exposure to, manure or animal/human faeces.

3.3.2 Storage and transport from the field to the packing facility

Fresh fruits and vegetables should be stored and transported under conditions which will minimize the potential for microbial, chemical or physical contamination. The following practices should be adopted:

- Storage facilities and vehicles for transporting the harvested crops should be built in a manner to minimize damage to fresh fruits and vegetables and to avoid access by pests. They should be made of non-toxic materials that permit easy and thorough cleaning. They should be constructed in a manner to reduce the opportunity for potential contamination from physical objects such as glass, wood, plastic, etc.
- Fresh fruits and vegetables unfit for human consumption should be segregated before storage or transport. Those which cannot be made safe by further processing should be disposed of properly to avoid contamination of fresh fruits and vegetables or agricultural inputs.
- Agricultural workers should remove as much soil as possible from fresh fruits and vegetables before they are stored or transported. Care should be taken to minimize physical damage to crop during this process.
- Transport vehicles should not be used for the transport of hazardous substances unless they are adequately cleaned, and where necessary disinfected, to avoid cross-contamination.

3.4 CLEANING, MAINTENANCE AND SANITATION

Premises and harvesting equipment should be kept in an appropriate state of repair and condition to facilitate cleaning and disinfection. Equipment should function as intended to prevent contamination of fresh fruits and vegetables. Cleaning materials and hazardous substances such as agricultural chemicals should be specifically identifiable and kept or stored separately in secure storage facilities. Cleaning materials and agricultural chemicals should be used according to manufacturer's instructions for their intended purpose.

3.4.1 Cleaning programmes

Cleaning and disinfection programmes should be in place to ensure that any necessary cleaning and maintenance is carried out effectively and appropriately. Cleaning and disinfection systems should be monitored for effectiveness and should be regularly reviewed and adapted to reflect changing circumstances. Specific recommendations are as follows:

- Harvesting equipment and re-usable containers that come in contact with fresh fruits and vegetables should be cleaned, and, where appropriate, disinfected on a regular basis.
- Harvesting equipment and re-usable containers used for fresh fruits and vegetables that are not washed prior to packing should be cleaned and disinfected as necessary.

3.4.2 Cleaning procedures and methods

The appropriate cleaning methods and materials will depend on the type of equipment and the nature of the fruit or vegetable. The following procedure should be adopted:

- Cleaning procedures should include the removal of debris from equipment surfaces, application of a detergent solution, rinsing with water, and, where appropriate, disinfection.

3.4.3 Pest control systems

When primary production is carried out in indoor establishments (e.g. greenhouses), the recommendations of the *General Principles of Food Hygiene*, section 6.3 should be followed with respect to pest control.

3.4.4 Waste management

Suitable provision must be made for the storage and removal of waste. Waste must not be allowed to accumulate in fresh fruit and vegetable handling and storage areas or the adjoining environment. Storage areas for waste should be kept clean.

4. PACKING ESTABLISHMENT: DESIGN AND FACILITIES

Refer to the *General Principles of Food Hygiene*.

5. CONTROL OF OPERATION

5.1 CONTROL OF FOOD HAZARDS

Refer to the *General Principles of Food Hygiene*.

5.2 KEY ASPECTS OF HYGIENE CONTROL SYSTEMS

5.2.1 Time and temperature control

Refer to the *General Principles of Food Hygiene*.

5.2.2 Specific process steps

5.2.2.1 Post-harvest water use

Water quality management will vary throughout all operations. Packers should follow GMPs to prevent or minimize the potential for the introduction or spread of pathogens in processing water. The quality of water used should be dependent on the stage of the operation. For example, clean water could be used for initial washing stages, whereas water used for final rinses should be of potable quality.

- Post-harvest systems that use water should be designed in a manner to minimize places where product lodges and dirt builds up.
- Antimicrobial agents should only be used where absolutely necessary to minimize cross-contamination during post-harvest and where their use is in line with good hygienic practices. The antimicrobial agents levels should be monitored and controlled to ensure that they are maintained at effective concentrations. Application of antimicrobial agents, followed by a wash as necessary, should be done to ensure that chemical residues do not exceed levels as recommended by the Codex Alimentarius Commission.
- Where appropriate, the temperature of the post-harvest water should be controlled and monitored.
- Recycled water should be treated and maintained in conditions that do not constitute a risk to the safety of fresh fruits and vegetables. The treatment process should be effectively monitored and controlled.
- Recycled water may be used with no further treatment provided its use does not constitute a risk to the safety of fresh fruits and vegetables (e.g. use of water recovered from the final wash for the first wash).
- Ice should be made from potable water. Ice should be produced, handled and stored to protect it from contamination.

5.2.2.2 Chemical treatments

- Packers should only use chemicals for post-harvest treatments (e.g. waxes, fungicides) in accordance with the *General Standard on Food Additives* or with the Codex Pesticide Guidelines. These treatments should be carried out in accordance with the manufacturer's instructions for the intended purpose.
- Sprayers for post-harvest treatments should be calibrated regularly to control the accuracy of the rate of application. They should be thoroughly washed in safe areas when used with different chemicals and on different fruits or vegetables to avoid contaminating the produce.

5.2.2.3 Cooling of fresh fruits and vegetables

- Condensate and defrost water from evaporator type cooling systems (e.g. vacuum cooling, cold rooms) should not drip onto fresh fruits and vegetables. The inside of the cooling systems should be maintained clean.
- Potable water should be used in cooling systems where water or ice is in direct contact with fresh fruits and vegetables (e.g. hydro cooling, ice cooling). The water quality in these systems should be controlled and maintained.
- Forced-air cooling is the use of rapid movement of refrigerated air over fresh fruits and vegetables in cold rooms. Air cooling systems should be appropriately designed and maintained to avoid contaminating fresh produce.

5.2.2.4 Cold storage

- When appropriate, fresh fruits and vegetables should be maintained at low temperatures after cooling to minimize microbial growth. The temperature of the cold storage should be controlled and monitored.
- Condensate and defrost water from the cooling system in cold storage areas should not drip on to fresh fruits and vegetables. The inside of the cooling systems should be maintained in a clean and sanitary condition.

5.2.3 Microbiological and other specifications

Refer to the *General Principles of Food Hygiene*.

5.2.4 Microbial cross-contamination

Refer to the *General Principles of Food Hygiene*.

5.2.5 Physical and chemical contamination

Refer to the *General Principles of Food Hygiene*.

5.3 INCOMING MATERIAL REQUIREMENTS

Refer to the *General Principles of Food Hygiene*.

5.4 PACKING

Refer to the *General Principles of Food Hygiene*.

5.5 WATER USED IN THE PACKING ESTABLISHMENT

Refer to the *General Principles of Food Hygiene*.

5.6 MANAGEMENT AND SUPERVISION

Refer to the *General Principles of Food Hygiene*.

5.7 DOCUMENTATION AND RECORDS

Where appropriate, records of processing, production and distribution should be kept long enough to facilitate a recall and food borne illness investigation, if required. This period could be much longer than the shelf life of fresh fruits and vegetables. Documentation can enhance the credibility and effectiveness of the food safety control system.

- Growers should keep current all relevant information on agricultural activities such as the site of production, suppliers' information on agricultural inputs, lot numbers of agricultural inputs, irrigation practices, use of agricultural chemicals, water quality data, pest control and cleaning schedules for indoor establishments, premises, facilities, equipment and containers.
- Packers should keep current all information concerning each lot such as information on incoming materials (e.g. information from growers, lot numbers), data on the quality of processing water, pest control programmes, cooling and storage temperatures, chemicals used in post-harvest treatments, and cleaning schedules for premises, facilities, equipment and containers, etc.

5.8 RECALL PROCEDURES

Refer to the *General Principles of Food Hygiene.*

In addition, where appropriate:

- Growers and packers should have programmes to ensure effective lot identification. These programmes should be able to trace the sites and agricultural inputs involved in primary production and the origin of incoming material at the packing establishment in case of suspected contamination.
- Growers' information should be linked with packers' information so that the system can trace products from the distributor to the field. Information that should be included are the date of harvest, farm identification, and, where possible, the persons who handled the fresh fruits or vegetables from the primary production site to the packing establishment.

6. PACKING ESTABLISHMENT: MAINTENANCE AND SANITATION

Refer to the *General Principles of Food Hygiene*.

7. PACKING ESTABLISHMENT: PERSONAL HYGIENE

Refer to the *General Principles of Food Hygiene*.

8. TRANSPORTATION

Refer to the *General Principles of Food Hygiene* and to the *Code of Hygienic Practice for the Transport of Food in Bulk and Semi-Packed Food*.

9. PRODUCT INFORMATION AND CONSUMER AWARENESS

Refer to the *General Principles of Food Hygiene*.

10. TRAINING

Refer to the *General Principles of Food Hygiene* except for section 10.1 and 10.2.

10.1 AWARENESS AND RESPONSIBILITIES

Personnel associated with growing and harvesting should be aware of GAPs, good hygienic practices and their role and responsibility in protecting fresh fruits and vegetables from contamination or deterioration. Agricultural workers should have the necessary knowledge and skills to enable them to carry out agricultural activities and to handle fresh fruits and vegetables and agricultural inputs hygienically.

Personnel associated with packing should be aware of GMPs, good hygienic practices and their role and responsibility in protecting fresh fruits and vegetables from contamination or deterioration. Packers should have the necessary knowledge and skills to enable them to perform packing operations and to handle fresh fruits and vegetables in a way that minimizes the potential for microbial, chemical, or physical contamination.

All personnel who handle cleaning chemicals or other potentially hazardous chemicals should be instructed in safe handling techniques. They should be aware of their role and responsibility in protecting fresh fruit and vegetables from contamination during cleaning and maintenance.

10.2 TRAINING PROGRAMMES

Factors to take into account in assessing the level of training required in growing, harvesting and packing activities include:

- The nature of the fruit or vegetable, in particular its ability to sustain growth of pathogenic micro-organisms.
- The agricultural techniques and the agricultural inputs used in the primary production including the probability of microbial, chemical and physical contamination.

- The task the employee is likely to perform and the hazards and controls associated with those tasks.
- The manner in which fresh fruits and vegetables are processed and packaged including the probability of contamination or microbial growth.
- The conditions under which fresh fruits and vegetables will be stored.
- The extent and nature of processing or further preparation by the consumer before final consumption.

Topics to be considered for training programmes include, but are not limited to, the following:

- The importance of good health and hygiene for personal health and food safety.
- The importance of hand washing for food safety and the importance of proper hand washing techniques.
- The importance of using sanitary facilities to reduce the potential for contaminating fields, produce, other workers, and water supplies.
- Techniques for hygienic handling and storage of fresh fruits and vegetables by transporters, distributors, storage handlers and consumer.

ANNEX I

ANNEX FOR READY-TO-EAT FRESH PRE-CUT FRUITS AND VEGETABLES

INTRODUCTION

The health benefits associated with fresh fruits and vegetables combined with the on–going consumer interest in the availability of a variety of ready-to-eat foods have contributed to a substantial increase in the popularity of pre-cut fruits and vegetables. Because of the increased convenience and consumption of pre-cut fruits and vegetables in and away from the home, the preparation of these products has moved from the point of consumption to the food processor or retailer. The processing of fresh produce without proper sanitation procedures in place in the manufacturing environment may enhance the potential for contamination by microbiological pathogens. The potential for pathogens to survive or grow may be enhanced by the high moisture and nutrient content of fresh-cut fruits and vegetables, the absence of a lethal process to eliminate them, and the potential for temperature abuse during processing, storage, transport, and retail display.

Some of the microbiological pathogens associated with fresh fruits and vegetables include *Salmonella* spp., *Shigella* spp., pathogenic strains of *Escherichia coli*, *Listeria monocytogenes*, Norwalk-like virus and hepatitis A virus and parasites such as Cyclospora. Some of these pathogens are associated with the agricultural environment, whereas others are associated with infected workers or contaminated water. Because of the ability for pathogens to survive and grow on fresh produce, it is important for the pre-cut industry to follow good hygienic practices to ensure the microbiological safety of its products.

1. OBJECTIVE

Hygienic recommendations for the primary production of fresh fruits and vegetables are covered under the *Code of Practice for Fresh Fruits and Vegetables*. This Annex recommends the application of Good Manufacturing Practices (GMPs) for all stages involved in the production of ready-to-eat fresh pre-cut fruits and vegetables, from receipt of raw materials to distribution of finished products.

The primary objective of this Annex is to identify GMPs that will help control microbiological, physical, and chemical hazards associated with the processing of fresh pre-cut fruits and vegetables. Particular attention is given to minimizing microbiological hazards. This Annex provides elements that should be taken into account in the production, processing and distribution of these foods.

2. SCOPE, USE AND DEFINITIONS

2.1 SCOPE

This Annex specifically applies to ready-to-eat fresh fruit and vegetables that have been peeled, cut or otherwise physically altered from their original form but remain in the fresh state and particularly those that are intended to be consumed raw. This Annex applies irrespective of where the operations take place (e.g. in the field, at the farm, at the retailer, at the wholesaler, at the processing establishment, etc.).

For some establishments that process fresh pre-cut fruit and vegetables, this Annex will cover all operations from receipt of raw material to the distribution of the final product. For other establishments, (e.g. those that use ready-to-eat pre-cut fresh fruit and vegetables in combination with other products, such as sauces, meat, cheese, etc.) only the specific sections that relate to the processing of the fresh pre-cut fruit and vegetable components will apply.

This Annex does not directly apply to fresh fruit and vegetables that have been trimmed leaving the food intact. Nor does it apply to other fresh fruit and vegetables that are pre-cut but are destined for further processing that would be expected to eliminate any pathogen that may be present (e.g. cooking, juice processing, fermentation) nor to fresh fruit or vegetable juices. However, some of the basic principles of the Annex could still be applicable to such products.

Packaging includes single serving containers (e.g. sealed pouches or plastic trays), larger consumer or institutional size packages and bulk containers. This Annex concentrates on microbial hazards and addresses physical and chemical hazards only in so far as these relate to GMPs.

2.2 USE

This document follows the format of the *General Principles of Food Hygiene* CAC/RCP 1-1969 and should be used in conjunction with the *General Principles of Food Hygiene* and the *Code of Hygienic Practice for Fresh Fruits and Vegetables*.

2.3 DEFINITIONS

Processor – the person responsible for the management of the activities associated with the production of ready-to-eat fresh pre-cut fruits and vegetables.

3. PRIMARY PRODUCTION

Refer to the *Code of Hygienic Practice for Fresh Fruits and Vegetables*.

4. ESTABLISHMENT: DESIGN AND FACILITIES

Refer to the *General Principles of Food Hygiene*. In addition:

4.4 FACILITIES

4.4.2 Drainage and waste disposal

The processing of products covered by this Annex generates a large quantity of waste that can serve as food and shelter for pests. It is therefore very important to plan an effective waste disposal system. This system should always be maintained in good condition so it does not become a source of product contamination.

5. CONTROL OF OPERATIONS

Refer to the *Code of Hygienic Practice for Fresh Fruits and Vegetables*. In addition:

5.1 CONTROL OF FOOD HAZARDS

For the products covered by this Annex it should be recognized that while processing may reduce the level of contamination initially present on the raw materials, it will not be able to guarantee elimination of such contamination. Consequently, the processor should ensure that steps are taken by their suppliers (growers, harvesters, packers and distributors) to minimize contamination of the raw materials during primary production. It is recommended that processors ensure that their suppliers have adopted the principles outlined in the *Code of Hygienic Practice for Fresh Fruits and Vegetables*.

There are certain pathogens, *Listeria monocytogenes* and *Clostridium botulinum*, which present specific concern in relation to ready to eat fresh pre-cut vegetables packaged in a modified atmosphere. Processors should ensure that they have addressed all relevant safety issues relating to the use of such packaging.

5.2 KEY ASPECTS OF CONTROL SYSTEMS

5.2.2 Specific process steps

5.2.2.1 Receipt and inspection of raw materials

During unloading of raw material, verify the cleanliness of the food transportation unit and raw materials for evidence of contamination and deterioration

5.2.2.2 Preparation of raw material before processing

Physical hazards (such as the presence of animal and plant debris, metal, and other foreign material) should be removed through manual sorting or the use of detectors, such as metal detectors. Raw materials should be trimmed to remove any damaged, rotten or mouldy material.

5.2.2.3 Washing and microbiological decontamination

Refer to section 5.2.2.1 of the *Code of Hygienic Practice for Fresh Fruits and Vegetables*. In addition:

- Water used for final rinses should be of potable quality, particularly for these products as they are not likely to be washed before consumption.

5.2.2.4 Pre-cooling fresh fruits and vegetables

Refer to section 5.2.2.3 of the *Code of Hygienic Practice for Fresh Fruits and Vegetables*.

5.2.2.5 Cutting, slicing, shredding, and similar pre-cut processes

Procedures should be in place to minimize contamination with physical (e.g. metal) and microbiological contaminants during cutting, slicing, shredding or similar pre-cut processes.

5.2.2.6 Washing after cutting, slicing, shredding, and similar pre-cut processes

Washing cut produce with potable water may reduce microbiological contamination. In addition, it removes some of the cellular fluids that were released during the cutting process thereby reducing the level of available nutrients for microbiological growth. The following should be considered:

- Water should be replaced at sufficient frequency to prevent the build-up of organic material and prevent cross-contamination.
- Antimicrobial agents should be used, where necessary, to minimize cross-contamination during washing and where their use is in line with good hygienic practices. The antimicrobial agents levels should be monitored and controlled to ensure that they are maintained at effective concentrations. Application of antimicrobial agents, followed by a wash as necessary, should be done to ensure that chemical residues do not exceed levels as recommended by the Codex Alimentarius Commission.
- Drying or draining to remove water after washing is important to minimize microbiological growth.

5.2.2.7 Cold storage

Refer to section 5.2.2.4 of the *Code of Hygienic Practice for Fresh Fruits and Vegetables*. In addition:

- Pre-cut fresh fruits and vegetables should be maintained at low temperatures at all stages, from cutting through distribution to minimize microbiological growth.

5.7 DOCUMENTATION AND RECORDS

Where appropriate, records should be maintained to adequately reflect product information, such as product formulations or specifications and operational controls. Maintaining adequate documentation and records of processing operations is important in the event of recall of with fresh pre-cut fruits and vegetables. Records should be kept long enough to facilitate recalls and foodborne illness investigations, if required. This period will likely be much longer than the shelf life of the product. Some examples of records to keep are the following:

- Fresh fruit and vegetable supplier records
- Water quality and supply records
- Equipment monitoring and maintenance records
- Equipment calibration records
- Sanitation records
- Product processing records
- Pest control records
- Distribution records

5.8 RECALL PROCEDURES

Refer to the *General Principles of Food Hygiene*.

6. ESTABLISHMENT: MAINTENANCE AND SANITATION

Refer to the *General Principles of Food Hygiene*.

7. ESTABLISHMENT: PERSONAL HYGIENE

Refer to the *General Principles of Food Hygiene*.

8. TRANSPORTATION

Refer to the *General Principles of Food Hygiene* and the *Code of Hygienic Practice for Fresh Fruits and Vegetables*.

9. PRODUCT INFORMATION AND CONSUMER AWARENESS

Refer to the *General Principles of Food Hygiene*.

10. TRAINING

Refer to the *General Principles of Food Hygiene* and the *Code of Hygienic Practice for Fresh Fruits and Vegetables*. In addition:

10.2 TRAINING PROGRAMMES

To evaluate the level of training required of persons responsible for the production of fresh pre-cut fruits and vegetables, the additional following factors should be taken into account:

- the packaging systems used for fresh pre-cut fruits and vegetables, including the risks of contamination or microbiological growth involved in this method;
- the importance of temperature control and GMPs.

ANNEX II

ANNEX FOR SPROUT PRODUCTION

INTRODUCTION

In recent years the popularity of sprouted seeds has increased dramatically and are favoured by many for their nutritional value. However, the recent increase in reports of food borne illness associated with raw sprouts has raised concerns from public health agencies and consumers about the safety of these products.

The microbial pathogens associated with sprouted seeds are for example *Salmonella* spp, pathogenic *E.coli*, *Listeria monocytogenes*, and *Shigella* spp. Outbreak investigations have indicated that micro-organisms found on sprouts most likely originate from the seeds. Most seeds supplied to sprout producers are produced primarily for forage or animal grazing where the Good Agricultural Practices (GAPs) necessary to prevent microbial contamination of seeds intended for sprouting are not followed, especially through the misuse of natural fertilizers or contaminated irrigation water. As a result, the seeds may be contaminated in the field or during harvesting, storage or transportation. Typically, the germination process in sprout production involves keeping seeds warm and moist for two to ten days. In these conditions, if low levels of microbial contaminants are present on seeds, they can quickly reach levels high enough to cause illness.

The scientific literature proposes microbiological decontamination of seeds treatments which can achieve different levels of pathogen reduction. There is currently no treatment available that can guarantee pathogen free seeds. Research is in progress to find efficient microbiological decontamination treatments which would provide sufficient pathogen reduction on seeds especially if pathogens are internalized.

1. OBJECTIVES

This annex recommends control measures to occur in two areas: during seed production and during sprout production. During seed production, conditioning and storage, the application of Good Agricultural Practices (GAPs) and Good Hygienic Practices (GHPs) are aimed at preventing microbial pathogen contamination of seeds. During sprout production, the microbiological decontamination of seeds step is aimed at reducing potential contaminants and the good hygienic practices at preventing the introduction of microbial pathogens and minimizing their potential growth. The degree of control in these two areas has a significant impact on the safety of sprouts.

2. SCOPE, USE AND DEFINITIONS

2.1 SCOPE

This annex covers the hygienic practices that are specific for the primary production of seeds for sprouting and the production of sprouts for human consumption in order to produce a safe and wholesome product.

2.2 USE

This annex follows the format of the *General Principles of Food Hygiene* CAC/RCP 1-1969 and should be used in conjunction with the *General Principles of Food Hygiene* and the *Code of Hygienic Practice for Fresh Fruit and Vegetables*.

2.3 DEFINITIONS

Seed producer – any person responsible for the management of activities associated with the primary production of seeds including post-harvest practices.

Seed distributor – any person responsible for the distribution of seeds (handling, storage and transportation) to sprout producers. Seed distributors may deal with single or multiple seed producers and can be producers themselves.

Sprout producer – any person responsible for the management of the activities associated with the production of sprouted seeds.

Spent irrigation water – water that has been in contact with sprouts during the sprouting process.

3. PRIMARY PRODUCTION OF SEEDS

Refer to the *Code of Hygienic Practice for Fresh Fruits and Vegetables*. In addition:

3.2 HYGIENIC PRODUCTION OF SEEDS

3.2.1.2 Manure and biosolids

When seeds are destined for the production of sprouts for human consumption, wild or domestic animals should not be allowed to graze in the fields where seeds are grown (e.g., employing sheep for spring clip back of alfalfa).

It is particularly important to prevent microbial contamination during the production of seeds which will be used to produce sprouts for human consumption because of the potential for pathogens to grow during the sprouting process. Consequently, manure, biosolids and other natural fertilizers should only be used when they have undergone treatments which achieve a high level of pathogen reduction.

3.2.1.4 Agricultural chemicals

Seed producers should only use chemicals (e.g., pesticides, desiccants) which are acceptable for seeds intended for the production of sprouts for human consumption.

3.2.4 Equipment associated with growing and harvesting

Prior to harvest, harvesting equipment should be adjusted to minimize soil intake and seed damage and should be cleaned from any debris or earth. Diseased or damaged seeds, which could be susceptible to microbial contamination, should not be used for the production of sprouts for human consumption.

3.3 HANDLING, STORAGE AND TRANSPORT

Seeds produced for the production of sprouts for human consumption should be segregated from product to be seeded or planted for animal feed (e.g. for forage or animal grazing) and clearly labelled.

Recognizing that seeds are vulnerable to microbial pathogens during thrashing and drying, adequate care is needed to maintain sanitation in drying yards, and exposure of seeds to mist, high humidity and fog should be avoided.

3.4 ANALYSES

Seed producers, distributors, and sprout producers should test lots of seeds for microbial pathogens using internationally accepted analytical methods. Sprouting seeds before testing increases the possibility of finding pathogens that may be present. If lots of seeds are found to be contaminated, they should not be sold or used for the production of sprouts for human consumption. Because of the limitations associated with sampling methods and analytical tests, failure to find contamination does not guarantee that the seeds are pathogen free. However, if contamination is found at this stage, it allows seeds to be diverted or destroyed before entering sprout production for human consumption. Seed producers, distributors and sprout producers should refer to the *Principles and Guidelines for the Establishment and Application of Microbiological Criteria related to Foods,* CAC/GL 21-1997, for guidance on establishing a sampling plan.

3.5 RECALL PROCEDURES

Seed producers for the production of sprouts for human consumption should ensure that records and recall procedures are in place to effectively respond to health risk situations. Procedures should enable the complete and rapid recall of any implicated seed. The procedures should also assist in providing detailed information for the identification and investigation of any contaminated seeds and sprouts. The following should be adopted:

- Seed production and distribution practices should be in place to minimize the quantity of seed identified as a single lot and avoid the mixing of multiple lots that would complicate recalls and provide greater opportunity for cross-contamination. Seed producers and distributors and sprout producers should maintain records for each lot. The lot number, producer and country of origin should be indicated on each container.
- Seed producers should have a system to: effectively identify lots, trace the production sites and agricultural inputs associated with the lots, and allow physical retrieval of the seeds in case of a suspected hazard.
- Where a lot has been recalled because of a health hazard, other lots that were produced under similar conditions (e.g., on the same production sites or with the same agricultural inputs) and which may present a similar hazard should be evaluated for safety. Any lot presenting a similar risk should be recalled. Blends containing potentially contaminated seeds must also be recalled.
- Seeds which may present a hazard must be held and detained until they are disposed of properly.

4. ESTABLISHMENT FOR SPROUT PRODUCTION

Refer to the *General Principles of Food Hygiene*. In addition:

4.2.1 Design and layout

Where appropriate, the internal design and layout of sprout establishments should permit Good Hygiene Practices, including protection against cross-contamination between and during operations. Storage, seed rinsing and microbiological decontamination, germination and packaging areas should be physically separated from each other.

5. CONTROL OF OPERATION

Refer to the *General Principles of Food Hygiene*. In addition:

5.2.2 Specific process steps in sprout production

5.2.2.1 Water use during sprout production

Water quality management will vary throughout all operations. Sprout producers should follow GMPs to minimize the potential for the introduction or spread of pathogens in processing water. The quality of water used should be dependent on the stage of the operation. Because of the potential for pathogen proliferation

during the sprouting process, clean water could be used for initial washing stages, whereas water used later in the sprout production process (i.e. for the rinse following the microbiological decontamination of seed, and subsequent operations) should be preferably of potable quality or at least clean water.

5.2.2.2 Initial rinse

The seeds should be rinsed thoroughly before the microbiological decontamination treatment to remove dirt and increase the efficiency of this treatment.

- Seeds should be rinsed and thoroughly agitated in large volumes of clean water, in such a way to maximize surface contact. The process should be repeated until most of the dirt is removed and rinse water remains clear.

5.2.2.3 Microbiological decontamination of seeds

Due to the difficulty of obtaining seeds which can be guaranteed as pathogen free, it is recommended that seeds be treated prior to the sprouting process. Although there are other options like the use of lactic acid bacteria, liquid microbiological decontamination treatment is generally used. During this treatment sprout producers should adhere to the following:

- All containers used for microbiological decontamination of seeds should be cleaned and disinfected prior to use.
- Seeds should be well agitated in large volumes of antimicrobial agent to maximize surface contact.
- The duration of treatment and the concentration of antimicrobial agent used should be accurately measured and recorded.
- Strict measures should be in place to prevent re-contamination of seeds after the microbiological decontamination treatment.
- Antimicrobial agent should be used according to manufacturer's instructions for their intended use.

5.2.2.4 Rinse after seed treatment

As appropriate, seeds should be thoroughly rinsed after the microbiological decontamination treatment with potable water or at least clean water. Rinsing should be repeated sufficiently to eliminate antimicrobial agent.

5.2.2.5 Pre-germination soak

Soaking is often necessary to improve germination. When soaking, the sprout producer should adhere to the following:

- All containers used for soaking should be cleaned and disinfected prior to use.
- Seeds should be soaked in cleaned water for the shortest possible time to minimize microbial growth.
- This step may also employ antimicrobial agents.
- After soaking, seeds should be rinsed thoroughly with potable water or at least clean water.

5.2.2.6 Germination

During germination, keep the environment and equipment clean to avoid potential contamination. All equipment should be cleaned and disinfected before each new batch.

- Only potable water should be used.
- Where necessary and when used, soils or other matrices should be treated (e.g., pasteurized) to achieve a high degree of microbial reduction.

5.2.2.7 Harvesting

All equipment should be cleaned and disinfected before each new batch. Harvesting should be done with cleaned and disinfected tools dedicated for this use.

5.2.2.8 Final rinse and cooling

A final water rinse will remove hulls, cool product, and may reduce microbial contamination on sprouts. The following should be adopted:

- As appropriate, sprouts should be rinsed in cold potable water to lower sprout temperature and slow down microbial growth.
- Water should be changed, as needed (e.g. between batches), to prevent cross-contamination.
- Sprouts should be drained using appropriate equipment (e.g. food grade centrifugal dryer) that is clean and disinfected prior to use.
- If additional cooling time is necessary, steps should be taken to facilitate rapid cooling (e.g. placed in smaller containers with adequate air flow between containers).

5.2.2.9 Storage of finished product

- Where appropriate, sprouts should be kept under cold temperature (e.g. 5^0C) that will minimize microbial growth for the intended shelf life of the product. Regular and effective monitoring of temperature of storage areas and transport vehicles should be carried out.

5.2.3 Microbiological and other specifications

It is recommended that seed and sprouts or spent irrigation water be tested for the presence of pathogens.

5.2.3.1 Testing of seed lots before entering production

It is recommended that each new lot of seeds received at the sprouting facility is tested before entering production (i.e. before the microbiological decontamination of seeds).

- The seed sample selected for testing should be sprouted prior to analysis to increase the potential to detect pathogens if present. Analysis may be performed on the sprouted seeds or the water used to sprout the sample.
- Seed samples for microbial analysis should not be subject to any microbiological decontamination treatment at the sprouting facility.

5.2.3.2 Testing of sprouts and/or spent irrigation water

Current seed treatments cannot guarantee total elimination of pathogens. Further, if even a few pathogens survive the microbiological decontamination treatment, they can grow to high numbers during sprouting. Therefore, producers should have in place a sampling/testing plan to regularly monitor for pathogens at one or more stages after the start of germination.

- Analyses can be performed during the germination process (e.g. spent irrigation water or sprouts) and/or finished product may be analysed after harvest.
- Testing spent irrigation water is a good indicator of microbial conditions of sprouts. It is homogeneous and is simpler to analyse. Further, sampling spent irrigation water (or sprouts) during germination allows earlier results compared to testing finished product.
- Because of the sporadic nature of seed contamination, it is recommended that producers test every production lot.

5.2.4 Microbiological cross-contamination

Sprout producers should adhere to the following:

- The traffic pattern of employees should prevent cross-contamination of sprouts. For example: the employees should avoid going back and forth to various areas of production. The employees should not go from a potentially contaminated area to the germination and/or packaging area unless they have washed their hands and changed to clean protective clothing.

5.3 INCOMING MATERIAL REQUIREMENTS

5.3.1 Specifications for incoming seeds

- Sprout producers should recommend that seed producers adopt good agricultural practices and provide evidence that the product was grown according to section 3 of this Annex and the *Code of Hygienic Practice for Fresh Fruits and Vegetables*.
- Seed and sprout producers should obtain assurance from seed producers or distributors that chemical residues of each incoming lot are within the limits established by the Codex Alimentarius Commission and, where appropriate, they should obtain certificates of analysis for microbial pathogens of concern.

5.3.2 Control of incoming seeds

Seed containers should be examined at their arrival to minimize the potential for introducing obvious contaminants in the establishment.

- Seed containers should be examined for physical damage (e.g. holes from rodents) and signs of contamination (e.g. stains, rodent, insects, faeces, urine, foreign material, etc.). If found to be damaged, contaminated or potentially contaminated, its contents should not be used for the production of sprouts for human consumption.
- If seed lots are analysed for the presence of microbial pathogens of concern, these should not be used until results of analysis are available.

5.3.3 Seed storage

Seeds should be handled and stored in a manner that will prevent damage and contamination.

- Seeds should be stored off the floor, away from walls and in proper storage conditions to prevent mould and bacterial growth and facilitate pest control inspection.
- Open containers should be stored in such a way that they are protected from pests and other sources of contamination.

5.7 DOCUMENTATION AND RECORDS

Refer to the *Code of Hygienic Practice for Fresh Fruits and Vegetables*. In addition:

Written records that accurately reflect product information and operational controls should be available to demonstrate the adequacy of the production activities.

- Upon receipt of seeds, records should be maintained of the seed supplier, the lot number and the country of origin to facilitate recall procedures.
- Records should be legible, permanent and accurate. Records should include written procedures, controls, limits, monitoring results and subsequent follow-up documents. Records must include: seed sources and lot numbers, water analysis results, sanitation checks, pest control monitoring, sprout lot codes, analysis results, production volumes, storage temperature monitoring, product distribution and consumer complaints.
- Records should be kept long enough to facilitate recalls and food borne illness investigation, if required. This period will likely be much longer than the shelf life of the product.

6. ESTABLISHMENT: MAINTENANCE AND SANITATION

Refer to the *General Principles of Food Hygiene*.

7. ESTABLISHMENT: PERSONAL HYGIENE

Refer to the *General Principles of Food Hygiene*.

8. TRANSPORTATION

Refer to the *General Principles of Food Hygiene*.

9. PRODUCT INFORMATION AND CONSUMER AWARENESS

Refer to the *General Principles of Food Hygiene*.

10. TRAINING

Refer to the *General Principles of Food Hygiene*. In addition:

10.1 AWARENESS AND RESPONSIBILITIES

Refer to the *Code of Hygienic Practice for Fresh Fruits and Vegetables*. In addition:

- The producer should have a written training programme that is routinely reviewed and updated. Systems should be in place to ensure that food handlers remain aware of all procedures necessary to maintain the safety of sprouts.

ANNEX III

ANNEX ON FRESH LEAFY VEGETABLES

INTRODUCTION

Fresh leafy vegetables are grown, processed and consumed in multiple ways and in diverse conditions throughout the world. They are grown on farms that vary from very large to very small. Fresh leafy vegetables are marketed both locally and globally to provide year round availability to consumers and are sold as fresh, fresh-cut, pre-cut or ready-to-eat products such as pre-packaged salads.

International and national concerns have grown in response to recent outbreaks and reported illnesses linked to fresh leafy vegetables. A broad array of microbial pathogens have been associated with fresh leafy vegetables as reported in international outbreak data, including Enterohemorrhagic *Escherichia coli*, *Salmonella enterica*, *Campylobacter* spp, *Shigella* spp, Hepatitis A virus, Norovirus, *Cyclospora cayetanensis*, *Cryptosporidium parvum*, *Guardia lamblia Yersinia pseudotuberculosis* and *Listeria monocytogenes*. Epidemiological evidence, outbreak investigations and risk assessments have identified areas of risk for pathogen contamination of leafy vegetables including key risks from water, animals, workers and manure based soil amendments. Fresh leafy vegetables are grown and harvested in large volume, often for export and increasingly in places that are new to harvesting and distributing fresh leafy vegetables therefore the potential for human pathogens to spread has also grown. Fresh leafy vegetables are marketed as diverse products including whole, unprocessed heads, loose leaves, mixed cut leaves and fresh herbs, and pre-cut packaged products. Fresh leafy vegetables are packed in diverse ways including field packed direct for market, in packing houses and processed for pre-cut products in sophisticated processing plants. As fresh, fresh-cut, pre-cut or ready to eat leafy vegetables move through the supply chain, there is also the potential for the introduction and growth of pathogens. There is no further processing treatment that would eliminate or inactivate the target microorganisms. Examples of control measures are illustrative only and their use and approval may vary between member countries.

1. OBJECTIVE

The objective of this Annex is to provide specific guidance to reduce the microbial food safety risks associated with fresh leafy vegetables that are intended to be consumed without cooking during their production, harvesting, packing, processing, storage, distribution, marketing and consumer use. This includes fresh, fresh-cut, pre-cut or ready-to-eat products such as pre-packaged salads. Because of the diversity of leafy vegetables and practices and conditions used throughout the supply chain, recommendations to minimize microbial contamination will be most effective when adapted to specific operations.

2. SCOPE, USE AND DEFINITIONS

2.1 SCOPE

This Annex covers specific guidance related to the production, harvesting, packing, processing, storage, distribution, marketing, and consumer use of fresh leafy vegetables that are intended to be consumed without further microbiocidal steps.

Fresh leafy vegetables for purposes of this Annex include all vegetables of a leafy nature where the leaf is intended for consumption. Thus, leafy vegetables include but are not limited to all varieties of lettuce, spinach, cabbage, chicory, endive and radicchio and fresh herbs such as coriander/cilantro, basil, and parsley).

2.2 USE

This Annex follows the format of the *General Principles of Food Hygiene* (CAC/RCP 1-1969) and should be used in conjunction with the General Principles of Food Hygiene and the *Code of Hygienic Practices for Fresh Fruits and Vegetables* (CAC/RCP 53-2003) including the Annex for Ready-To-Eat Fresh Pre-Cut Fruits and Vegetables. This Annex provides additional guidance to the documents above.

3. PRIMARY PRODUCTION OF FRESH LEAFY VEGETABLES

3.1 ENVIRONMENTAL HYGIENE

The following should be considered:

Potential sources of environmental contamination should be identified prior to production activities. Assessment of environmental conditions is particularly important because subsequent steps may not be adequate to remove contamination that occurs during production and in some cases may lead to conditions that enable the growth of microbial pathogens.

Particular attention should be given to potential sources of faecal contamination in the production area, on near-by sites and to vectors which may introduce faecal contamination to the production and handling areas. These vectors include, but are not limited, to humans, domestic and wild animals, or indirectly via contaminated water, insects, workers, or fomites such as dust, tools and equipment.

3.1.1 Location of the Production Site

Production sites (indoor and outdoor) should be located to minimize the probability of microbial contamination to the growing sites from the nearby sites. Consideration of land location should include evaluating the slope, topographical, flood risk, and hydrological features of nearby sites in relationship to the production site.

Assessing environmental hygiene is particularly important in evaluating risks that arise from use of land nearby the production sites, for example feed lots, other animal production operations, hazardous waste sites, municipal and industrial waste treatment facilities, The presence of such sites should be evaluated for their potential to contaminate the production site with microbial or other environmental hazards via, for example, run-off, faecal material, aerosols or organic waste.

Where the environment presents a risk to the production site, measures should be implemented to minimize the contamination of the fresh leafy vegetable production sites. Landscape changes, such as the construction of a shallow ditch, to prevent runoff from entering the field or in the case of aerosols, construction of an effective wind-break (natural such as trees or constructed) or use of a covering are examples of measures that can be used to reduce pathogen contamination of the production site.

3.1.2 Previous and current use of the site

If the evaluation of previous and present usage of the primary production area and the nearby sites identifies potential microbial hazards that are at levels that pose a risk to humans, including faecal and other organic waste contamination and potential environmental hazards, fresh leafy vegetables should not be grown on the land until the risks have been reduced to acceptable levels.

3.1.3 Wild and domestic animals and human activity

Domestic and wild animals and human activity can present a risk both from direct contamination of the crop and soil as well as from contamination of surface water sources and other inputs.

- Domestic and wild animals should be excluded from production and handling areas, to the extent feasible, using appropriate biological, cultural, physical and chemical pest control methods. Methods selected should comply with local, regional, and national environmental and animal protection regulations.
- Production and handling areas should be properly maintained (*e.g.* minimizing standing water and/or access to water sources, keeping areas free of clutter and waste) to reduce the likelihood of vector attraction.
- Existing practices should be reviewed to assess the prevalence and likelihood of deposits of animal faeces coming into contact with crops. Considering this potential source of contamination, efforts should be made to protect fresh leafy vegetable growing areas from animals. When appropriate, this may require the use of physical barriers (*e.g.* fences), active deterrents (*e.g.* noise makers, scarecrows, images of owls, foil strips) and/or cultural methods (*e.g.* crop rotation).

  Wild animals represent a particularly difficult risk to manage because their presence is intermittent and harder to track. Fields should be monitored for human and animal activity (*e.g.* presence of tracks, faeces, crop damage from grazing, etc.), particularly near harvesting. If present, consideration should be given to the risks and whether affected crop areas should be harvested.

3.2 HYGIENIC PRIMARY PRODUCTION OF FRESH LEAFY VEGETABLES

3.2.1.1 Water for primary production

An appropriate and adequate supply of water of a suitable quality for use in different operations in the primary production of fresh leafy vegetables should be available. The source of the water used for production and the method of delivery can affect the risk of contamination for fresh leafy vegetables. Growers should seek appropriate guidance on water quality and delivery methods to minimize the potential for contamination with microbial pathogens.

The quality of water may vary. Water for primary production that has substantial contact with the edible portion of the leafy vegetable should meet the standards for potable or clean water. Examples of water sources that present the lowest risk of contamination are:

- Rain water, provided the integrity of the water distribution system is maintained
- Water in deep wells, provided they are maintained, monitored and capped
- Water in shallow wells provided they are maintained, monitored and capped

Water sources that pose a higher risk of contamination may need further treatment such as:

- Surface water

Option such as sand filtration or storage in catchments or reservoirs to achieve partial biological treatment should be considered. The efficacy if these treatments should be evaluated and monitored.

- Reclaimed or wastewater

Before using reclaimed or wastewater for crop irrigation, consult with an expert to assess the relative risk and determine the suitability of the water source. Reclaimed wastewater subjected to different levels of treatment should be in compliance with WHO guidelines for safe use of wastewater, excreta and grey water, wastewater use in agriculture, in agricultural production specifically on irrigating vegetables marketed to consumers as fresh, fresh-cut, pre-cut or ready-to-eat.

Growers and harvesters should identify the sources of water used on the farm (municipality, re-used irrigation water, reclaimed wastewater, discharge water from aquaculture, well, open canal, reservoir, rivers, lakes, farm ponds, etc.). Growers should assess and manage the risk posed by these waters as follows:

- Assess the potential for microbial contamination (e.g., from livestock, human habitation, sewage treatment, manure and composting operations) and the water's suitability for its intended use and re-assess the potential for microbial contamination if events, environmental conditions or other conditions indicate that water quality may have changed.
- Identify corrective actions to prevent or minimize contamination. Possible corrective actions may include fencing to prevent large animal contact, appropriate well casing and head maintenance and placement of wells, filtering water, not stirring the sediment when drawing water, building settling or holding ponds, and water treatment facilities. Settling or holding ponds that are used for subsequent irrigation may be microbiologically safe but may attract animals or in other ways increase the microbial risks associated with water for irrigating crops. If water treatment is needed, consult with water safety authorities.
- Determine if analytical testing should be done to evaluate the suitability of water for each intended use. Analytical testing may be necessary after a change in irrigation water source, flooding or a heavy rainfall when water is at a higher risk of contamination. If testing, determine and document what tests need to be performed, how often tests should be conducted, what the test outcomes indicate, and how tests will be used to define corrective actions. The frequency of testing will partially depend on the water source (less for adequately maintained deep wells, more for surface water) and the risks of environmental contamination including intermittent or temporary contamination (*e.g.* heavy rain, flooding, *etc*.). If testing is limited to non-pathogenic indicators, frequent water tests may be useful to establish the baseline water quality so that changes in the levels of contamination can be identified. Obtain municipal water test results when available. If the water source is found to have unacceptable levels of indicator organisms or is known to be contaminated, corrective actions should be taken to ensure that the water is suitable for its intended use. Testing frequency should be increased until consecutive results are within the acceptable range.

3.2.1.1.1 Water for irrigation

Water used for irrigation purposes should be of suitable quality for its intended use. The type of irrigation or application method affects the risk of contamination. The timing, the quality of water used, and whether the water has direct contact with the edible portion of the plant should all be considered when selecting the type of irrigation or application method to use.

Growers should:

- Evaluate the water distribution system to determine if a contamination source is evident and can be eliminated.
- Establish no-harvest zones if irrigation source water is known to or likely to contain human pathogens and where failure at connections results in overspray of plants or localized flooding.

Overhead irrigation presents the highest risk of contamination because it wets the edible portion of the crop. The duration for wetting can be several hours, and the physical force of water droplet impact may drive contamination into protected sites on the leaf. Therefore, only the clean water should be used for this type of irrigation.

Subsurface or drip irrigation that results in no wetting of the plant is the irrigation method with the least risk of contamination, although these methods can still experience localized problems. For drip-irrigation, care should be taken to avoid creating pools of water on the soil surface or in furrows that may come into contact with the edible portion of the crop.

Irrigation of fresh leafy vegetables that have physical characteristics such as rough surfaces where water may accumulate, a vase-like growth characteristic, or high density seeding or transplant rates should be irrigated with only clean water. Irrigation of these products should be applied in a way to minimize wetting of the edible portion because the plant characteristics can provide niches for microbial attachment and survival.

3.2.1.1.2 Water for fertilizers, pest control and other agricultural chemicals

Clean water should be used in the application of aqueous fertilizers, pesticides, and other agricultural chemicals that are directly applied to edible portions of the fresh leafy vegetables, especially close to harvest. Human pathogens can survive and grow in many agrichemicals including pesticides. The application of pesticide solutions contaminated with human pathogens to the surface of leafy vegetables is known to constitute a risk, particularly near harvest time.

3.2.1.1.3 Hydroponic water

Microbial risks of water used in growing fresh leafy vegetables hydroponically may differ from the microbial risks of water used to irrigate leafy vegetables in soil because the water in hydroponic production is used for both irrigation and as the growth medium and presents therefore a higher risk of microbiological contamination. The growth medium may enhance the survival of pathogens. It is especially critical in hydroponic operations to maintain the water quality to reduce the risk of contamination and survival of pathogens.

3.2.1.1.4 Water for harvesting and other agricultural uses

Water for other agricultural uses includes dust abatement, hydration, as a lubricant, and to maintain roads, yards, and parking lots so that they do not constitute a source of contamination in areas where fresh leafy vegetables are exposed. If sprinkling water using mechanical means to minimize dust on dirt roads within or near the fields, then use clean water to avoid the aerosolization and spread of pathogens.

Fresh leafy vegetables may be sprayed with small amounts of water during machine harvest or in the field container just after harvest to hydrate crops. Water may also be used to facilitate the handling of leafy vegetables in the field. Clean water should be used in processes were there is direct contact between the water and edible portions of the leafy vegetables. It is understood that products at this point are not considered ready-to-eat and may be washed or further processed.

3.2.1.2 Manure, biosolids and other natural fertilizers

Manure, biosolids and other natural fertilizers may contain human or animal waste, animal parts or products, or be composed primarily of plant materials. Because of this, natural fertilizers and other soil amendments may contain human pathogens that may persist for weeks or even months, particularly if treatment of these materials is inadequate

Proper treatment of biosolids, manures and by-products (e.g. physical, chemical, or biological treatment) will reduce the risk of potential human pathogen survival. The persistence of human pathogens in soil depends on many factors (soil type, relative humidity, temperature, Ultraviolet Index[1] and pathogen type among other known factors). Composting, if done properly, can be a practical and efficient method to inactivate human pathogens in manure. When using aerobic composting methods, compost heaps should be regularly and thoroughly turned so that all of the material will be exposed to elevated temperatures because pathogens can survive for months on the heap surface. Anaerobic methods can also effectively inactivate pathogens; however, special consideration should be given to determine the length of time needed to inactivate pathogens that may be present. In general, only fully decomposed animal waste or plant materials should be applied to fresh leafy vegetables**.**

Fresh leafy vegetables may be contaminated through direct contact with contaminated soil amendments. Therefore untreated and/or partially treated manure, biosolids, and other natural fertilizers should not be applied to leafy vegetables after plant emergence unless it can be demonstrated that product contamination will not occur. Field soil contaminated with human pathogens may also provide a means of fresh leafy vegetables contamination via rain splash or plant uptake. Therefore, establishing suitably conservative pre-plant fertilizer intervals appropriate for specific regional and field conditions is an effective step towards minimizing risk. Competent authorities should provide guidance on appropriate intervals.

3.2.2 Indoor facilities associated with growing and harvesting (protective agricultural structures)

Protective agricultural structures, including greenhouses, high tunnels, hoop houses, and shade house structures, provide some degree of control over various environmental factors.

3.2.2.1 Location, design and layout

The following should be considered:

3.2.2.2 Protective agricultural structures

Some protective agricultural structures are located in the field (hoop houses, high tunnels, etc.) Factors that influence the magnitude and frequency of the transfer of pathogenic microorganisms in the field, such as the climate, weather, topology, hydrology and other geographic characteristics in or nearby the field may pose a similar risk for certain protective structures.

The methods for adequate maintenance of the environment around the structures include, but are not limited to:

- Properly storing equipment, removing litter and waste, and cutting weeds or grass within the immediate vicinity of the plant buildings or structures that may constitute an attractant, breeding place, or harborage for pests.
- Adequately draining areas that may contribute contamination to food by
  - providing a breeding place for pests
  - runoff, leakage, or pooled/settled water flowing into food growing areas,
    - transfer of contaminants via equipment or foot traffic
- The land nearby certain protective structures (high tunnel, hoop house, *etc.*) should not be a significant source of contamination. Appropriate measures should be taken to minimize any relative risks from surrounding land use or environment. These measures may include berms, fences, ditches, buffer zones or other strategies to effectively mitigate any hazards.

3.2.2.3 Water supply

Refer to 3.2.1.1.1 (Water for Irrigation) and 3.2.1.1.3 (Hydroponic Water)

3.2.2.4 Drainage and waste disposal

The following should be considered:

- Good drainage should be maintained around the structure to eliminate standing water.

[1] Ultraviolet Index (UVI)**:** a measure of the solar ultraviolet intensity at the earth's surface that indicates the day's exposure to ultraviolet rays. The UV Index is measured around noon for a one-hour period and rated on a scale of 0 to 15 based on international guidelines for UVI reporting established by the World Health Organization.

- Waste disposal systems and facilities should be provided. All refuse should be disposed of in containers with lids and stored away from the facility to prevent harbourage of pests.
- Refuse containers should be emptied regularly.

3.2.2.5 Cleaning, maintenance and sanitation

- Workers and visitors should take effective measures (e.g. wash hands) before entering greenhouses.
- Plant debris and cull piles should be removed promptly from inside the structure. There should be no plant refuse around the outside of the structure or nearby to attract or harbour pests.

3.2.3 Personnel health, hygiene and sanitary facilities

The following should be considered:

- Each businesses operating primary production should have written Standard Operating Procedures (SOPs) that relate to health, hygiene and sanitary facilities. The SOPs should address worker training, facilities and supplies to enable workers to practice proper hygiene, and company policies relating to expectations for worker hygiene as well as illness reporting.
- All workers should properly wash their hands using soap and clean, running water before handling leafy vegetables, particularly during harvesting and post harvest handling. Workers should be trained in proper technique for hand washing and drying.
- If gloves are used, a procedure for glove use in the field should be documented and followed. If the gloves are reusable, they should be made of materials that are readily cleaned and sanitized, should be cleaned as needed and stored appropriately. If disposable gloves are used, they should be discarded when they become torn, soiled, or otherwise contaminated.
- Non-essential persons and casual visitors, particularly children, should not be allowed in the harvest area as they may present an increased risk of contamination.

3.2.3.1 Personnel hygiene and sanitary facilities

The following should be considered

- Growers should provide areas away from the field and packing lines for workers to take breaks and eat. For worker convenience, these areas should contain toilet and hand washing facilities so workers can practice proper hygiene.
- All workers should be trained in proper use of hygienic facilities. Training should include toilet use, proper disposal of toilet paper or equivalent, and proper hand washing and drying procedures.

As far as possible, such facilities should be located close to the field and readily accessible to the work area:

- Sanitary facilities should be located in a manner to encourage their use and reduce the likelihood that workers will relieve themselves in the field. Facilities should be in sufficient number to accommodate personnel (e.g. 1 per 10 people) and be appropriate for both genders if workforce contains males and females.
- Portable facilities should not be located or cleaned in cultivation areas or near irrigation water sources or conveyance systems. Growers should have a standard plan that identifies the areas where it is safe to put portable facilities and to prevent traffic in case of a spill.
- Facilities should include clean running water, soap, toilet paper or equivalent, and single use paper towels or equivalent.

3.2.3.2 Health status

The following should be considered:

- Farm and packinghouse managers should be encouraged to observe symptoms of diarrhoeal or food transmissible communicable diseases and reassign workers as appropriate.
- Employees should be encouraged to notice and report symptoms of diarrhoeal or food transmissible communicable diseases.
- Medical examination of food handlers should be carried out if clinically or epidemiologically indicated.

3.2.3.3 Personal cleanliness

When personnel are permitted to continue working with cuts and wounds covered by water proof dressings, they should wear gloves to cover the bandages thereby providing a secondary barrier between them and the fresh leafy vegetables they handle.

- Workers should wear clean clothes and bathe daily.

3.2.3.4 Personal behaviour

- Personal items (e.g. purses, backpacks, clothes, etc.) should be stored away from production areas.

3.2.4 Equipment associated with growing and harvesting

Growers and harvesters should adopt the following sanitary practices:

- Employees should be trained to follow SOPs for the maintenance requirements of equipment used for growing and harvesting.
- All safety guards should be used and maintained according to manufacturers' instructions. Such equipment should be maintained in good order.

- Equipment used to harvest leafy vegetables by cutting or mowing should be thoroughly cleaned and sanitized before use and cutting edges should be kept smooth and sharp.

3.3 HANDLING, STORAGE AND TRANSPORT

3.3.1 Prevention of cross-contamination

The following should be considered:

- The field should be evaluated for the presence of hazards or contamination prior to harvest to determine if the field should be harvested.
- Written SOPs should be developed for appropriate handling, storage, and transport.
- Excessive dirt and caked mud should be removed from product and/or containers during harvest.
- If water is used to remove dirt and debris from leafy vegetables in the field, clean water should be used.

Harvesting methods vary depending upon the characteristics of the product. Mechanical harvesting provides opportunity for increased surface contact exposure and may cause damage that could lead to penetration of plant tissues by microorganisms. Specific control measures should be implemented to minimize the risk of contamination from microorganisms associated with the method, such as prevention of sucking up soils and other field contaminants and components that may damage or cut plants.

- Personal hygiene is critical with manual harvesting due to the amount of human handling that could lead to contamination of the leafy vegetables.
- Proper cleaning and sanitation of equipment is also important for manual and mechanical harvesting, since knives and other equipment used can wound fresh leafy vegetables, lead to cross contamination, and provide entry for contaminants that may be in soil and water.
- Over-filling of totes and bins should be avoided to prevent transfer of contaminants to produce during stacking.

3.3.2 Storage and transport from the field to the packing facility

Refer to the *Code of Hygienic Practice for the Transport of Food in Bulk and Semi-Packed Food* (CAC/RCP 47-2001). In addition, the following should be considered:

Fresh leafy vegetables may be transported to the packing, cooling and cold storage facility by numerous modes of transportation. Transportation should be managed to reduce or control the risk of contamination. Each transporter should have its own SOP for shipping containers/trailers to verify that they are clean, sanitary, and in good structural condition.

Fresh produce should not be transported in vehicles used previously to carry animal manure or biosolids. Receptacles in vehicles and/or containers are not to be used for transporting anything other than foodstuffs where this may result in contamination. Where conveyances and/or containers are used for transporting anything in addition to foodstuffs or for transporting different foodstuffs at the same time, there is, where necessary, to be effective separation of products.

Fresh leafy vegetables are perishable products that should be carefully handled. Damage will adversely affect the quality of the product and may increase its potential for microbial contamination. Damaged product should be discarded.

- Maintaining optimum temperatures of leafy vegetables between 1-5^{o}C throughout the supply chain or minimizing the time they are exposed to higher temperature will limit microbial proliferation and, depending on the type of the product, may be optimum for quality. Consideration should be given to the type of product, particularly certain fresh herbs (e.g. basil and shiso) that are chill sensitive and may require higher storage temperatures to prevent quality deterioration that could leave the product vulnerable to foodborne pathogens. For this type of product, minimizing the time it is exposed to a higher temperature might be preferable to maintaining the temperature below 5^{o}C.
- Cover product to maintain integrity of the load.

3.4 CLEANING, MAINTENANCE AND SANITATION

3.4.1 Cleaning programmes

The following should be considered:

- Harvesting containers that come into direct contact with leafy vegetables should not be utilized for purposes other than holding product (*e.g*. should not hold personal items, waste, *etc*.).
- Single use primary containers such as cardboard boxes or clamshells should not be reused in food contact applications.
- Containers should be covered and stored in a location and in a manner to prevent possible contamination (*e.g.* pests, birds, rodents, dust, water, etc.).
- Damaged containers should be repaired or replaced.
- Containers that come into direct contact with the soil should not be stacked in such a manner as to allow soil and debris to contaminate fresh leafy vegetables.

- Policies should be established for the control of equipment when it is not in use, including policies for the removal of equipment from the work area or site and for the use of scabbards, sheathes or other storage equipment.
- Harvesting equipment, including hand harvesting implements (knives, pruners, corers, machetes) that come in direct contact with fresh leafy vegetables, should be cleaned and sanitized at least daily or as the situation warrants.
- Clean water should be used to clean all equipment directly contacting fresh leafy vegetables, including farm machinery, harvesting and transportation equipment, containers and implements.

3.4.2 Cleaning procedures and methods

The following should be considered:

- Cleaning and disinfection programmes should not be carried out in a location where the rinse might contaminate fresh leafy vegetables.
- Where appropriate or necessary, cleaning and sanitizing procedures should be tested to ensure their effectiveness.

4. PACKING ESTABLISHMENT: DESIGN AND FACILITIES

Refer to the *Guidelines on the Application of General Principles of Food Hygiene to the Control of Listeria monocytogenes in Ready-to-eat Foods* (CAC/GL 61-2007). In addition, the following should be considered:

Packing activities can occur in the field or in facilities. Field pack operations should implement the same sanitary practices where practical or modify as needed to minimize risks.

The provisions below apply to facilities that pack, cool and process fresh leafy vegetables.

4.1.1 Establishments

The following should be considered:

- Floors and walls should be of a material that is easily cleanable and does not pose a risk for harbourage or growth of foodborne microorganisms.
- Pipes should not leak and condensation should be minimized to avoid dripping on product or packing equipment

4.4.2 Drainage and waste disposal

The following should be considered:

Adequate drainage is critical to packing, cooling and processing facilities to avoid the risk of contaminating the fresh leafy vegetables. To ensure adequate drainage of standing water:

- Drainage in the facility should be designed with sloped floors to effectively drain standing water.
- Floors should be kept as dry as possible using appropriate methods.
- Food handlers should have proper training to remove standing water or push standing water to the drains.
- Drains should be cleaned periodically to prevent build-up of biofilms that may contain organisms of concern (*e.g. Listeria monocytogenes*).
- Areas for garbage recyclables and compostable waste should be identified and all waste should be stored and disposed of in a manner to minimize contamination.
- Waste should be disposed of on a frequent basis to avoid attracting pests (e.g. flies, rodents).

5. CONTROL OF OPERATION

5.1 CONTROL OF FOOD HAZARDS

Establishments should pay special attention to product flow and segregation from incoming soiled to outgoing washed product to avoid cross-contamination.

5.2 KEY ASPECTS OF HYGIENE CONTROL SYSTEMS

5.2.2.1 Receipt and inspection of raw materials

Prior to preparation, damaged or decayed material (both at harvest and at the processing plant) should be trimmed and/or discarded.

5.2.2.2 Post-harvest water use

The following should be considered:

- Water quality management will vary throughout all operations. Packers should follow GMPs to prevent or minimize the potential for the introduction or spread of pathogens in processing water. The quality of water should be dependent on the stage of the operation. For example, clean water could be used for initial washing stages, whereas water used for final rinses should be of potable quality.
- Clean or preferably potable water should be used when water is applied under pressure or vacuum during washing as these processes may alter the leaf structure and force pathogens into plant cells.

- Where appropriate, the pH, hardness, temperature of the post-harvest water should be controlled and monitored, e.g., where these impact the efficacy of the antimicrobial treatments.
- Water recirculated for reuse in the establishment should be treated and maintained in conditions that do not constitute a risk to the safety of fresh leafy vegetables. For example the following may be used to maintain the suitability of the water: primary screening, secondary filtration, and antimicrobial treatment process.

5.2.2.3 Chemical treatments

Certain post harvest treatments, i.e. paraffin and fungicides, should not be used for fresh leafy green vegetables.

5.2.2.4 Cooling of fresh leafy vegetables

The following should be considered:

Fresh leafy vegetables can be cooled immediately after harvest by either, using ice (parsley), forced-air cooling, vacuum cooling (iceberg lettuce), hydrocooling, or spray-vacuum (hydrovac) cooling. Water used in post-harvest operations may contaminate fresh leafy vegetables if there is direct contact of water containing human pathogens with edible portions of the plant.

For fresh leafy vegetables and the control of inputs such as water used for cooling, particular attention should be paid to:

- Water used to cool fresh leafy vegetables should be free from human pathogens.
- Water that is used in hydrovacs should be clean or preferably potable. Water that is used only once and is not recirculated is preferable. If recirculated water is used, water disinfectant at sufficient levels to reduce the potential risk of cross-contamination should be used and monitored.
- Cooling equipment should be cleaned and sanitized on a regular basis according to written procedures to ensure that the potential for cross contamination is minimized.

5.2.2.6 Cutting, slicing, shredding and similar pre-cut processes

The following should be considered:

- Maintain sharpness and condition of knives and cutting edges to maintain product quality and safety.
- Cutting equipment should be cleaned and sanitized on a regular basis according to written procedures to ensure that the potential for cross contamination is minimized

5.2.3 Microbiological and other specifications

The following should be considered:

Microbiological testing can be a useful tool to evaluate and verify the effectiveness of safety and sanitation practices, provide information about an environment, a process, and even a specific product lot, when sampling plans and methodology are properly designed and performed. The intended use of information obtained (*e.g.* evaluating the effectiveness of a sanitation practice, evaluating the risk posed by a particular hazard, etc.) can aid in determining what microorganisms are most appropriate to test for. Test methods should be selected that are validated for the intended use. Consideration should be given to ensure proper design of a microbiological testing programme. Trend analysis of testing data should be undertaken to evaluate the effectiveness of food safety control systems.

5.7 DOCUMENTATION AND RECORDS

The following should be considered:

Where practicable, a comprehensive written food safety control plan that includes a written description of each of the hazards identified in assessing environmental hygiene and the steps that will be implemented to address each hazard should be prepared by the businesses operating primary production. The description should include, but is not limited to: an evaluation of the production site, water and distribution system, manure use and composting procedures, personnel illness reporting policy, sanitation procedures, and training programmes.

The following are examples of the types of records that should be retained:

- Microbiological testing results and trend analyses
- Water testing results
- Employee training records
- Pest control records
- Cleaning and sanitation reports
- Equipment monitoring and maintenance records
- Inspection/audit records

5.8 TRACEABILITY/PRODUCT TRACING AND RECALL PROCEDURES

The following should be considered:

The traceability/product tracing system should be designed and implemented according to the *Principles for Traceability/Products Tracing as a Tool within a Food Inspection and Certification System* (CAC/GL 60-2006), especially to enable the withdrawal of the products, where necessary..

- Detailed records should be kept that link each supplier of the product with the immediate subsequent recipient of the food throughout the supply chain. The information should include, if available, the packer name, address, and phone, date packed, date released, type of food including brand name and specific variety (*e.g*. Romaine lettuce rather than just lettuce), lot identification, and number of items,
- The following are examples of the types of records that should be retained to facilitate traceability:
    - Shipping documents
    - Invoices
    - Other records maintained by the firm that identifies the supplier and the buyer
- Operators such as growers and producers and, in cases where contract harvesters are used, harvesters should keep current all relevant information on agricultural activities such as information concerning each lot, date harvested, grower contact information, harvest practices, if water used in harvesting, water quality.
- In fresh-cut, pre-cut or ready-to-eat salad operations, multiple ingredients from different sources may be combined in a single package. This practice can complicate efforts to trace leafy vegetables to their source. The processors should consider establishing and maintaining records to identify the source of each ingredient in the product.

8. TRANSPORTATION

Refer to the *Code of Hygienic Practice for the Transport of Food in Bulk and Semi-Packed Food* (CAC/RCP 47-2001).

9. PRODUCT INFORMATION AND CONSUMER AWARENESS

Refer to the *General Principles of Food Hygiene*.

9.3 LABELLING

Refer to the *General Standard for the Labelling of Pre-packaged Food*s (CODEX STAN 1-1985) and In addition, the following should be considered:

- Consumer's handling information should provide specific directions for product storage and use, including regarding the 'use-by' date or other shelf-life indicators when provided. Consumers need clear guidance on keeping washed RTE bagged fresh leafy vegetables refrigerated until used.

9.4 CONSUMER EDUCATION

The following should be considered:

All stakeholders - government, industry, consumer organizations and the media - should work together to communicate clear consistent messages on handling fresh leafy vegetables safely to avoid giving contradictory advice and causing confusion.

Consumer information on handling fresh leafy vegetables safely should cover:

- Selecting produce in the marketplace (supermarkets, retailers). Many fresh leafy vegetables such as lettuce are fragile and should be handled with care to avoid mechanical damage and to minimize microbiological contamination.
- Transporting to home. Increases in product temperatures during transportation can be considerable. Time in transit for fresh leafy vegetables between retail/markets and the home should be kept as short as possible.
- Storage/refrigeration of fresh leafy vegetables.
- Washing leafy vegetables as appropriate with potable running water. Products labelled washed and ready-to-eat should not be rewashed.
- Correct hand washing methods using soap and potable water before handling fresh leafy vegetables should continue to be promoted to consumers.
- Cross-contamination. Consumers need to handle, prepare and store fresh leafy vegetables safely to avoid cross-contamination with pathogens from various sources e.g., hands, sinks, cutting boards, raw meats.
- Specific information for fresh-cut, pre-cut or ready-to-eat bagged salads. Consumers need specific and clear guidance on how to safely handle fresh-cut, pre-cut or ready-to-eat (RTE) leafy vegetables. Clear labelling is there important. There is anecdotal evidence to suggest that some consumers find it difficult to distinguish between product that can be consumed without further washing and that which requires washing before consumption, particularly bagged produce such as herbs and spinach.

10. TRAINING

10.1 AWARENESS AND RESPONSIBILITIES

The following should be considered:

- Making education and training a priority for all personnel.

10.2 TRAINING AND EDUCATION PROGRAMMES

The following should be considered:

Where required personnel involved in fresh leafy vegetable operations should receive training appropriate to their tasks and should be periodically assessed while performing their duties to ensure tasks are being completed correctly. Training should be delivered in a language and manner to facilitate understanding of the information and expectations. Training programmes should be designed to help personnel understand what is expected of them and why and it should emphasize the importance of using hygienic practices. A well-designed training programme considers the barriers to learning of the trainees and develops training methods and materials to overcome those barriers.

To accommodate the complexity of situations that exist in fresh leafy vegetable operations, the following training considerations should be addressed:

- Longstanding entrenched trainee behaviours, attitudes and social taboos
- Transient nature of workforce with no prior training in food safety and hygiene
- Children/infants, who may accompany parents working in the field with the potential for transfer of pathogens with a human reservoir
- Diverse cultural, social and traditional practices
- Literacy and education level
- Language and dialect of trainees
- Need to make food safety practices realistic and easy to implement (identify enabling factors, motivators and incentives)
- Raising awareness among trainees of symptoms and signs of disease and encourage them to act upon it (take personal responsibility for health)
- Importance of food safety training when new crops are being grown for the first time

Training programmes should be regular, updated particularly when there is a change in product variety or process recorded, monitored for effectiveness and modified when necessary.

Increased emphasis on training in cold chain logistics and management is recommended in line with advancing knowledge and technologies for both refrigeration and temperature monitoring and expanding international trade.

ANNEX IV

ANNEX FOR MELONS

INTRODUCTION

Melons, such as cantaloupe, watermelon, and honeydew, are often consumed alone, mixed with other foods in salads and other dishes and as garnishes. They are popular in meals and as snacks, and in some countries melons are a regular part of the diet. The popularity of melons has remained high as they are readily available in many countries all year round. In recent years there has been a focus on marketing not only whole melons, but pre-cut products, convenience products in packages, or in salad bars to appeal to consumers. Adding to consumer appeal for melons is the availability of new varieties that are seedless and the introduction of sweeter hybrid varieties.

Like other fresh fruits and vegetables that are eaten raw, the safety of melon products depends on maintaining good hygienic practices along the food chain during primary production, packing, processing, retail, and at the point of consumption. International outbreak data and reported illnesses raise concerns regarding the safety of melon products. There have been a number of outbreaks associated with melon consumption with a large number being caused by *Salmonella* spp[2.] Additionally other pathogens, such as *Listeria monocytogenes* have been associated with foodborne outbreaks from melons. The major risk factors that have been identified as contributing to melon outbreaks include: poor temperature control (including extended holding at ambient temperature and poor cold storage), infected food handlers and poor personal hygiene. As fresh and pre-cut melon products move through the food chain, there is also the potential for the introduction, growth and survival of foodborne pathogens due to cross contamination (arising from poor hygiene practices for personnel, transport, retail outlets, utensils or consumers). Moreover, morphological characteristics of certain types of melons, for instance netted rind, will be prone to attachments by microbial pathogens. Fresh melons are consumed without further processing treatment that would eliminate or inactivate pathogens, if present.

SECTION 1 - OBJECTIVES

Hygienic recommendations for the primary production of fresh fruits are covered in general under the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RCP 53-2003). The primary purpose of this Annex is to provide specific guidance on how to minimize microbiological hazards during primary production through packing and transport of fresh melons, including fresh melons processed for the pre-cut market and consumer use.

SECTION 2 - SCOPE, USE AND DEFINITION

2.1 SCOPE

This annex covers specific guidance related to all areas, from primary production to consumption, of fresh melons that are intended to be consumed without further microbiocidal steps.

2.2 USE

This Annex follows the format of the *General Principles of Food Hygiene* (CAC/RCP 1-1969) and should be used in conjunction with it and other applicable codes such as the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RCP 53-2003) and Annex I, the *Annex for Ready-to-Eat Fresh Pre-cut Fruits and Vegetables,* and the *Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables* (CAC/RCP 44-1995).

2.3 DEFINITIONS

Refer to definitions in the *General Principles of Food Hygiene* and the *Code of Hygienic Practice for Fresh Fruits and Vegetables.* In addition, the following expressions have the meaning stated:

Cull means to remove any product that shows signs of physical damage (such as skin breaks or decay).

Ground spot means the point of direct contact where melons sit directly on the soil or on top of thin plastic mulch.

Melons in this document refers to whole and/or pre-cut cantaloupe (also known as muskmelons and rockmelons), honeydew, watermelon and other varieties of melons.

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[2] Report of the FAO to the Codex Committee on Food Hygiene Working Group on the development of an Annex on melons for the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RPC 53-2003)

SECTION 3 - PRIMARY PRODUCTION

Fresh melons are grown in production sites indoors (e.g. greenhouses) and outdoors, harvested, and either field-packed or transported to a packing establishment.

3.1 ENVIRONMENTAL HYGIENE

Potential sources of environmental contamination should be identified prior to production activities. This is important because contamination that occurs during production may not be removed during subsequent steps. In addition, melons grown in warm, humid conditions may favour growth and survival of foodborne pathogens. Growers should take steps to minimize the potential for contamination from any sources identified.

Particular attention should be given to potential sources of faecal contamination in the melon production area and to vectors which may introduce faecal contamination to the production and handling areas. These vectors include, but are not limited to, humans, domestic and wild animals, or indirectly from contaminated water, insects, or fomites such as dust, tools and equipment.

3.1.1 Location of the production site

Consideration of production site location should include an evaluation of the slope and the potential for runoff from nearby fields, the flood risk as well as hydrological features of nearby sites in relation to the production site.

The proximity of high risk production sites, such as animal production facilities, hazardous waste sites and waste treatment facilities, should be evaluated for the potential to contaminate melon production fields or the water sources used with microbial or other environmental hazards via, for example, run-off, faecal material, aerosols or organic waste. When the risks are serious these production sites should not be used for melon production.

When the environmental assessment identifies a potential food safety risk, measures should be implemented to minimize contamination of melons at the production site. Consideration should be given to changing the landscape surrounding melon production fields, such as the construction of a shallow ditch to prevent runoff from entering the fields, to reduce the potential for pathogen contamination of melons in the production site. The effects of some environmental events, such as heavy rains, cannot be controlled. For example, heavy rains may increase melons' exposure to pathogens if soil contaminated with pathogens splashes onto melon surfaces. Consideration could be given to harvesting earlier if the weather forecasts heavy rain or to delaying harvest and performing extra washing when heavy rains have recently occurred.

3.1.2 Wild and domestic animals and human activity

Many animal species (e.g. insects, birds, amphibians, chickens, feral pigs, livestock and domestic or wild dogs) and humans that may be present in the production environment are known to be potential carriers of foodborne pathogens. Animals are a common source of contamination of surface water that may be used for irrigation. The following should be considered:

- Domestic and wild animals should be excluded from production and handling areas, to the extent possible, using appropriate biological, cultural, physical and chemical pest control methods. Methods selected should comply with local, regional, and national environmental and animal protection regulations.
- Melon production and handling areas should be properly maintained to reduce the likelihood of vector attraction. Activities to consider include efforts to minimize standing water in fields, restrict access by animals to water sources (may be based on local ordinances for public irrigation systems), and keep production sites and handling areas free of waste and clutter.
- Melon production sites and handling areas should be evaluated for evidence of the presence of wildlife or domestic animal activity (e.g. presence of animal faeces, hairs/furs, large areas of animal tracks, burrowing, or decomposing remains). Where such evidence exists, growers should evaluate the risks and whether the affected sections of the melon production sites should be harvested.

3.2 HYGIENIC PRIMARY PRODUCTION OF MELONS

Special consideration should be given to production practices specific to melon production because of the unique characteristics of the melons and the rind of some melons and because melons frequently contact soil directly during growth and development. Melons may have smooth or netted rind surfaces. Netted rind surfaces, in contrast to smooth rind surfaces, provide an environment where microbial pathogens may more easily adhere to, survive on, and become more difficult to eliminate during post-harvest practices. It is recommended that growers use production practices that prevent or minimize contact of melons, particularly those with netted rinds, with soil, soil amendments (including natural fertilizers) or irrigation water.

Some growers place melons on cups (i.e. small plastic pads) or plastic mulch-covered beds (wider and more elevated during the wet season), or halved bamboo segments to minimize direct melon-to-soil contact and thereby reduce ground spot development. Melons also may be hand-turned multiple times by agricultural workers during the growing season to prevent sunburn or ground spot development or covered with biodegradable materials such as rice straw to prevent sunburn. Melon rind ground spots have been demonstrated to have significantly greater microbial populations than non-ground spot areas and, therefore, may be more susceptible to microbial contamination. If cups or biodegradable materials are used underneath melons, the following are recommended:

- Use plastic mulch under cups to minimize cup and melon contact with the soil.
- Ensure cups are clean and sanitary before setting them under the melons.

- Ensure that employees follow good hygienic practices when turning melons on the cups or during harvesting operations.

- Use biodegradable materials only once to prevent cross-contamination.

3.2.1.1 Water for primary production

Growers should identify the sources of water used on the farm (municipality, re-used, irrigation water, reclaimed wastewater, discharge water from aquaculture, well, open canal, reservoir, rivers, lakes, farm ponds, etc.). It is recommended that growers assess and manage the risk posed by these waters as follows:

- Assess the potential for microbial contamination (e.g. from animals, human habitation, sewage treatment, manure and composting operations) and the water's suitability for its intended use. Reassess the potential for microbial contamination if events, environmental conditions (e.g. temperature fluctuations, heavy rainfall, etc.) or other conditions indicate that water quality may have changed.

- Identify and implement corrective actions to prevent or minimize contamination. Possible corrective actions may include fencing to prevent large animal contact, proper maintenance of wells, filtering water, not stirring the sediment when drawing water, building settling or holding ponds, and water treatment facilities. Settling or holding ponds that are used for subsequent irrigation may attract animals or in other ways increase the microbial risks associated with water for irrigating melons. If water treatment is needed, consult with water safety experts.

- Determine if microbial and chemical testing should be done to evaluate the suitability of water for each intended use. Analytical testing may be necessary after a change in irrigation water source, flooding or a heavy rainfall when water is at a higher risk of contamination. If testing, determine and document.
    - What tests need to be performed, (e.g. which pathogens and/or sanitary indicators)
    - Which parameters should be noted (e.g. temperature of water sample, water source location, and/or weather description),
    - How often tests should be conducted,
    - What the test outcomes indicate, and
    - How tests will be used to define corrective actions.

- Frequency of testing should depend on the source of the irrigation water (less for adequately maintained deep wells, more for surface waters) and the risks of environmental contamination, including intermittent or temporary contamination (e.g. heavy rain, flooding, etc.).

- If water testing is limited to non-pathogenic indicators, frequent water tests may be useful to establish the baseline water quality so that subsequent changes in the levels of contamination can be identified.

- If the water source is found to have unacceptable levels of indicator organisms or is contaminated with foodborne pathogens, corrective actions should be taken to ensure that the water is suitable for its intended use. Testing frequency should be increased until consecutive results are within the acceptable range.

3.2.1.1.1 Water for irrigation

Netted melon rind surfaces, in contrast to smooth rind surfaces, may foster greater attachment and survival of foodborne pathogens. For this reason, the quality of irrigation water and type of irrigation method used is an important consideration. Growers should consider the following:

- Avoid overhead irrigation methods, particularly with netted rind melons, because wetting the outer rind of melons increases the risk of pathogen contamination. Overhead irrigation also enhances downy mildew infection in melons.

- Subsurface or drip irrigation presents the least risk of contaminating melon surfaces. For drip irrigation, care should be taken to avoid creating pools of water on the soil surface or in furrows that may come into contact with melon rinds.

3.2.1.1.2 Water for fertilizers, pest control and other agricultural chemicals

Clean water, should be used in the application of aqueous fertilizers, pesticides and other agricultural chemicals that are directly applied to the surface of melons, especially close to harvest. Foodborne pathogens can survive and grow in many agrichemical solutions, including pesticides.

3.2.1.1.4 Water for harvesting and other agricultural uses

Clean water should be used for other agricultural purposes, such as dust abatement, hydration, use as a lubricant, and to maintain roads, yards, and parking lots in areas where melons are grown. This would include water used to minimize dust on dirt roads within or near melon production sites.

3.2.1.2 Manure, biosolids and other natural fertilizers

Manure, biosolids and other natural fertilizers may contain human or animal waste, animal parts or products, or be composed primarily of plant materials. Because of this, foodborne pathogens may be present and may persist for weeks or even months, particularly if treatment of these materials is inadequate.

Growers should consider the following when using any of these materials:

- Use proper treatment by physical, chemical or biological methods to reduce the risk of potential human pathogen survival.

- Composting, if done properly, can be a practical and efficient method to inactivate foodborne pathogens in manure. In general, only fully decomposed animal waste or plant material should be applied to melon fields.

- When using aerobic composting methods, regularly and thoroughly turn compost heaps to ensure that all of the material will be exposed to elevated temperatures because pathogens can survive for months on the heap surface.

- When using anaerobic methods, special consideration should be given to determine the length of time needed to inactivate pathogens that may be present.

- Use of untreated and/or partially treated manure, biosolids, and other natural fertilizers should not be used after plant emergence or after a transplant is put into the soil, unless it can be demonstrated that product contamination will not occur.

3.2.3 Personnel health, hygiene and sanitary facilities

The following should be considered:

- Where appropriate, each business operating primary production operations should have written Standard Operating Procedures (SOPs) that relate to health, hygiene and sanitary facilities. The SOPs should address worker training, facilities and supplies to enable agricultural workers to practice proper hygiene, and company policies relating to expectations for worker hygiene as well as illness reporting.

- All agricultural workers should properly wash their hands using soap and clean running water before handling melons, particularly during harvesting and post-harvest handling. Agricultural workers should be trained in proper techniques for hand washing and drying.

- If gloves are used, a procedure for glove use in the field should be documented and followed. If the gloves are reusable, they should be made of materials that are easily cleaned and disinfected, and they should be cleaned regularly and stored in a clean area. If disposable gloves are used, they should be discarded when they become torn, soiled, or otherwise contaminated.

- Non-essential persons, casual visitors and, to the extent possible, children, should not be allowed in the harvest area as they may present an increased risk of contamination.

3.2.3.1 Personnel hygiene and sanitary facilities

Growers should consider providing areas away from the field and packing lines for agricultural workers to take breaks and eat. For worker convenience, these areas should provide access to toilet and hand-washing facilities so that agricultural workers can practice proper hygiene.

As far as possible, sanitary facilities should be located close to the field and readily accessible to the work area.

- Sanitary facilities should be located in a manner to encourage their use and reduce the likelihood that agricultural workers will relieve themselves in the field. Facilities should be present in sufficient number to accommodate all personnel.

- Portable facilities should not be located or cleaned in cultivation areas or near irrigation water sources or conveyance systems. Growers should identify the areas where it is safe to put portable facilities.

- Facilities should include clean running water, soap, toilet paper or equivalent, and single use paper towels or equivalent. Multiple use cloth drying towels should not be used. Hand sanitizers should not replace hand washing and should be used only after hands have been washed.

- If clean running water is not available, an acceptable alternative hand washing method should be recommended by the relevant competent authority.

3.2.3.2 Health status

` The following should be considered:

- Growers should be encouraged to note symptoms of diarrhoeal or food-transmissible, communicable diseases, and reassign agricultural workers as appropriate.

- Agricultural workers should be encouraged and, where feasible, be motivated with appropriate incentives to report symptoms of diarrhoeal or food-transmissible, communicable diseases.

- Medical examination of agricultural workers should be carried out if clinically or epidemiologically indicated.

3.2.3.3 Personal cleanliness

When personnel are permitted to continue working with cuts and wounds covered by water proof dressings, they should wear gloves to cover the bandages thereby providing a secondary barrier between them and the melons they handle.

3.2.4 Equipment associated with growing and harvesting

Standard operating practices should be developed for the maintenance, cleaning and disinfecting operations of growing and harvesting equipment. In addition:

- Agricultural workers should be trained to follow the SOPs.
- Cutting equipment used to harvest melons should be thoroughly cleaned and disinfected before use and cutting edges should be kept smooth and sharp.

3.3 HANDLING, STORAGE AND TRANSPORT

Melons such as cantaloupe are harvested based on the melon's stage of maturity as judged by the formation of an abscission zone between the vine and the melon. After the vine is separated from the melon, a stem scar is left on the fruit. Melon stem scars may provide a potential route for entry of foodborne pathogens, if present, to the edible portion of the melons. It is recommended that post-harvest handling practices be implemented to minimize stem scar and rind infiltration, such as during washing operations, of foodborne pathogens into the edible portions of melon flesh. Where appropriate, written SOPs should be developed and implemented for safe handling, storage and transport of melons. It should be considered that the length of storage for melons at a recommended temperature depends on the stage of maturity when melons are harvested.

3.3.1 Prevention of cross-contamination

Specific control methods should be implemented to minimize the risk of cross-contamination from micro-organisms associated with manual harvesting methods. The following should be considered:

- The field should be evaluated for the presence of hazards or contamination prior to harvest to determine if the field should be harvested.
- Particularly with manual harvesting, as well as field packing operations, good personal hygiene should be implemented to prevent surface contamination of melons.
- Proper cleaning and disinfection of equipment should be done since knives, if improperly used, can wound melon rinds and provide a point of entry for contaminants that may be in soil and water.
- Avoid setting melons directly on soil after removal from the vine and before loading into transport vehicle to avoid contaminating the melon with contaminants in the soil.
- Harvest containers that come into contact with melons should not be used for purposes other than holding product (e.g. should not hold personal items, waste, etc.).

Melons are susceptible to damage during harvest and post-harvest handling operations. The following should be considered:

- When padding is used with post-harvest handling equipment to prevent damage to melons, it should be constructed of material that can be cleaned and disinfected. Ensure that padding is cleaned and disinfected before and during use.
- Minimize mechanical damage such as rind punctures, cracks, and bruising, as these wounds may provide entry points for pathogens and sites for microbial survival and multiplication.
- Train agricultural workers to recognize and not harvest damaged melons.
- Dispose of culled melons in a way that melon culls will not attract animal and insect pests. This will reduce the potential for contaminating melons still on the vine.

3.3.2 Storage and Transport from the production site to the packing/processing facility

Refer to the *Code of Hygienic Practice for the Transport of Food in Bulk and Semi-Packed Food* (CAC/RCP 47-2001)

- Transportation of fresh melons should be managed to reduce or control the risk of contamination. Each transporter should have its own SOP for shipping containers/trailers to confirm that they are clean, sanitary and in good structural condition.
- Fresh melons should not be transported in vehicles used previously to carry animals, animal manure or biosolids and pesticides unless they are adequately cleaned and disinfected. Receptacles and vehicles and/or containers, when being used to transport melons, are not to be used for transporting anything which may result in contamination of melons.
- Where conveyances and/or containers are used for transporting anything in addition to foodstuffs or for transporting different foodstuffs at the same time, there should, where necessary, be effective separation of products.
- When not in use, cleaned harvest containers and transport trailers should be covered and kept in a location and in a manner to prevent possible contamination (e.g., such as from pests, birds, rodents, dust, water, etc.).
- Damaged containers or transport trailers should be repaired or replaced.

3.4 CLEANING, MAINTENANCE AND SANITATION

3.4.1 Cleaning programmes

The following should be considered:

- Harvesting equipment, including knives, pruners, machetes, that come into direct contact with melons should be cleaned and disinfected at least daily or as the situation warrants.
- Clean water should be used to clean all equipment directly contacting melons, including farm machinery, harvesting and transportation equipment, containers and knives.

3.4.2 Cleaning procedures and methods

Cleaning and disinfection programmes should not be carried out in a location where the rinse water might contaminate melons.

Where appropriate or necessary, cleaning and disinfecting procedures should be validated to ensure their effectiveness.

SECTION 4 –ESTABLISHMENT: DESIGN AND FACILITIES

Refer to the *Guidelines on the Application of General Principles of Food Hygiene to the Control of Listeria monocytogenes in Ready-to-eat Foods* (CAC/GL 61-2007).

The provisions below apply to packing and processing establishments of melons.

4.2 PREMISES AND ROOMS

4.2.1 Design and layout

It is important to consider the sanitary design and layout for packing/processing equipment and the establishment because of the seasonal nature of the melon harvest. Packing/processing establishment operations may be used only a few months of the year and thus be dormant for many months, leaving them susceptible to pest infestations. When dormant, packing/processing establishment should be appropriately protected from pest infestations. Their design should allow thorough cleaning and disinfection of food contact surfaces to ensure microbial pathogens do not become established in the facility or on the equipment.

4.4 FACILITIES

4.4.2 Drainage and waste disposal

Adequate drainage is critical to packing, cooling and processing facilities to avoid the risk of contaminating melons. To ensure adequate drainage of standing water, consider the following:

- Drainage in the facility should be designed with sloped floors to effectively drain standing water.
- Floors should be kept as dry as possible using appropriate methods.
- Standing water should be removed or pushed to the drains.
- Drains should be cleaned periodically to prevent build-up of biofilms that may contain organisms of concern (e.g. *Listeria monocytogenes*).
- Areas for garbage recyclables and compostable waste should be identified and all waste should be stored and disposed of in a manner to minimize contamination.
- Waste should be disposed of on a frequent basis to avoid attracting pests (e.g. flies, rodents).

SECTION 5 - CONTROL OF OPERATION

5.1 CONTROL OF FOOD HAZARDS

Prevention of contamination is a key control point for all produce operations, including melon operations. Establishments should pay special attention to product flow and segregation of incoming soiled and outgoing washed product to avoid cross-contamination. If melons pass over brushes during the operations, care should be taken to ensure they do not damage or cross-contaminate the melons. They should be routinely inspected, cleaned and adjusted as needed.

5.2 KEY ASPECTS OF HYGIENE CONTROL SYSTEMS

5.2.2 Specific process steps

5.2.2.1 Post-harvest water use

Water is often used in dump tanks to transport melons from field containers into the packing or processing establishment. If the temperature of the water in the dump tank is cold and the internal temperature of the melons is hot from field heat, a temperature differential is created that may aid in the infiltration of microbial pathogens into the rind and/or the edible portion of the fruit. The following should be considered when using post-harvest water:

- Clean water should be used in dump tanks. Disinfectants may reduce, but will not eliminate microbial pathogens if present, as they are primarily used to disinfect the water.

- It is recommended that the time melons remain in dump tank water be minimized.

- Minimize or avoid fully submerging melons in colder dump tank water. When submerged, water is more likely to infiltrate into the melons.

- Where appropriate, the pH, soil (including organic) load, turbidity, water hardness, product through-put capacity should be controlled and monitored to ensure the efficacy of the antimicrobial treatment.

- Water temperatures should be higher than the internal temperatures of melons, so as to minimize the risk of water infiltration.

5.2.2.2 Chemical treatments

Fungicides may be applied to melons by use of an aqueous spray or immersion to extend the post-harvest life of the fruit. The following are recommended:

- Clean or preferably potable water should be used in water-based chemical treatments to ensure that the water used is of sufficient microbial quality for the intended use and does not contaminate the melons with foodborne pathogens.

- If hot water treatments are used as an alternative to post-harvest chemical fungicide treatments, it is recommended that the water temperature and time be evaluated and monitored to ensure that the water temperature and time is maintained and that antimicrobial agents are present in the water at sufficient levels for the temperature used.

5.2.2.3 Cooling melons

- Forced air cooling operations can avoid the risk of melon infiltration with cooling water, but also may spread product contamination if forced-air cooling equipment is not cleaned and disinfected regularly.

- Water that is used in hydro-coolers should be potable. Water that is used only once and not recirculated is preferable.

- If water is used for cooling and is recirculated, it should be evaluated and monitored to ensure that disinfectant levels are sufficient to reduce the potential risk of cross-contaminating melons.

- Cooling and cold storing melons as soon as possible after harvest is recommended to prevent multiplication of foodborne pathogens, if present, on or from the rind surface of melons.

- Cooling equipment should be cleaned and disinfected on a regular basis according to written procedures to ensure that the potential for cross-contamination is minimized.

5.2.2.5 Cutting, slicing and peeling melons

- Melons should be washed with potable water before cutting or peeling.

- Before cutting or other processing, a further reduction in microbial contamination may be achieved by scrubbing in the presence of a sanitizer or application of an alternative surface decontamination process such as hot water, steam or other treatments.

- Cutting or peeling knife blades should be cleaned and disinfected on a regular basis according to written procedures to reduce the potential for cross-contaminating melons during the cutting or peeling process.

- Knife blade disinfecting solutions should be monitored to ensure that the disinfectant is present at sufficient levels to achieve its intended purpose and does not promote the potential for cross-contamination.

- It is recommended that pre-cut melons should be wrapped/packaged and refrigerated as soon as possible and distributed under refrigeration temperatures (i.e. 4 °C or less).

5.2.3 Microbiological and other specifications

Microbiological testing can be a useful tool to evaluate and verify the effectiveness of safety and sanitation practices, provide information about an environment, a process, and even a specific product lot, when sampling plans and methodology are properly designed and performed. The intended use of information obtained (e.g., evaluating the effectiveness of a sanitation practice, evaluating the risk posed by a particular hazard, etc.) can aid in determining what micro-organisms are most appropriate to test for. Test methods should be selected that are validated for the intended use. Consideration should be given to ensure proper design of a microbiological testing programme. Trend analysis of testing data should be undertaken to evaluate the effectiveness of food safety control systems.

5.2.4 Microbiological cross-contamination

- Where dry dump stations are used for unloading field containers (e.g. bins, gondolas, trailers, or wagons), melon contact surfaces (including padding materials to protect melons from physical damage) should be constructed of material that can be cleaned and disinfected.

- Where wet dump stations are used for unloading field containers, the containers should not be directly immersed into dump tanks, where they have been in direct contact with the soil, to reduce the potential for product cross-contamination with field or road debris.

5.3 INCOMING MATERIAL REQUIREMENTS

- Avoid using whole melons that have visible signs of decay or damaged rinds (e.g. mechanical damage or cracking) due to the increased risk for microbial contamination in melons.

- Damaged or decayed melons should be discarded in a manner that does not serve to attract pests.

5.7 DOCUMENTATION AND RECORDS

Where practicable, a written food safety control plan that includes a written description of each of the hazards identified in assessing environmental hygiene, as well as the steps that will be implemented to address each hazard, should be prepared by the business operating the primary production. The description should include, but is not limited to, the following: an evaluation of the production site, water and distribution system, manure use and composting procedures, personnel illness reporting policy, sanitation procedures and training programmes.

The following are examples of the types of records that should be retained:

- Microbiological testing results and trend analyses
- Water monitoring and test results
- Employee training records
- Pest control records
- Cleaning and sanitation reports
- Equipment monitoring and maintenance records
- Inspection/audit records

5.8 RECALL PROCEDURES

In the event of a foodborne illness outbreak associated with melons, maintaining appropriate records of production, processing, packaging and distribution may help to identify the source of contamination in the melon food chain and facilitate product recalls. Growers/packers/processors/distributors should consider developing and maintaining a traceability/product tracing system. The traceability/product tracing system should be designed and implemented according to the principles for *Traceability/Products Tracing as a Tool within a Food Inspection and Certification System* (CAC/GL 60-2006), especially to enable the withdrawal of the products, where necessary.

Detailed records should be kept that link each supplier of the product with the immediate subsequent recipient of the melons throughout the food chain. The information needed to link each supplier should include, if available, the packer name, address, and phone number, date packed, date released, type of melon (e.g. cantaloupe, watermelon, etc.) including brand name, lot identification and number of lots, and transporter.

SECTION 6 – ESTABLISHMENT: MAINTENANCE AND SANITATION

6.1 MAINTENANCE AND CLEANING

6.1.1 General

Food contact surfaces should be cleaned and disinfected before the start of the season and throughout the melon season to ensure microbial pathogens do not become established in the facility or on the equipment.

6.3 PEST CONTROL SYSTEMS

Melons have a very high sugar content and are extremely attractive to flies and other insects that may cross-contaminate melons. It is recommended that an aggressive melon cull disposal and waste removal programme be implemented to reduce the potential for insect-to-melon contamination.

SECTION 8 – TRANSPORTATION

Refer to the *Code of Practice for the Packaging and Transport of Fresh Fruits and Vegetables* (CAC/RCP 44-1995)

SECTION 9 – PRODUCT INFORMATION AND CONSUMER AWARENESS

9.4 CONSUMER EDUCATION[3]

The following should be considered:

- All stakeholders – government, industry, consumer organizations and the media – should work together to communicate clear consistent messages on handling melons safely to avoid giving contradictory advice and causing confusion.

Consumer information on handling melons safely should cover:

- Avoiding the selection of melons with damaged rinds or rotten areas.
- Transporting to home. Increase in product temperature during transportation can be considerable. Time in transit for pre-cut melons between retail/market and the home should be kept as short as possible.
- Storage/ refrigeration of whole and pre-cut melons. Whole melons should preferably be stored in a cool environment. All prepackaged and pre-cut melons should be refrigerated as soon as possible.
- Once removed from the refrigerator, pre-cut fruit should be consumed as soon as possible.
- Washing and/or scrubbing whole melons, particularly the netted varieties, (i.e. cantaloupes) using potable running water and where appropriate, disinfectant solutions. Pre-cut products should not be rewashed.
- Correct hand washing methods[4].
- Cross-contamination. Consumers need to handle, prepare, and store melons safely to avoid cross-contamination with pathogens from various sources (e.g., hands, sinks, cutting boards, utensils, raw meats).

SECTION 10 – TRAINING

10.2 Training programmes

Personnel involved in primary production, packing, processing or transport operations of melons should receive training appropriate to their tasks and should be periodically assessed while performing their duties to ensure tasks are being completed correctly. Training should be delivered in a language and manner to facilitate understanding of what is expected of them and why, and should emphasize the importance of using hygienic practices. A well-designed training programme considers the barriers to learning of the trainees and develops training methods and materials to overcome those barriers.

All agricultural workers should be trained in proper use of hygiene facilities. Training could include, for example, toilet use, proper disposal of toilet paper or equivalent, and proper hand washing and drying procedures.

The following training considerations should be addressed:

- Longstanding entrenched trainee behaviours, attitudes or personal beliefs
- Transient nature of workforce with no prior training in food safety and hygiene
- Concerns about children/infants who may accompany parents working in the production site with the potential for transfer of pathogens with a human reservoir
- Diverse cultural, social and traditional practices
- Literacy and education level
- Language and dialect of trainees
- Need to make food safety practices realistic and easy to implement (identify enabling factors, motivators and incentives)
- Raising awareness among trainees of the symptoms and signs of disease and encourage them to act upon it (taking personal responsibility for health)

Training programmes should be repeated periodically, and updated whenever there is a change in the product, process or staff and monitored for effectiveness and modified when necessary.

Increased emphasis on training in cold chain logistics and management is recommended, in line with advancing knowledge and technologies for both refrigeration and temperature monitoring and expanding international trade.

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[3] " The WHO Five Keys to Safer Food" message and its supporting materials offer simple and clear guidance for food handlers including consumers on safe food handling (http://www.who.int/foodsafety/publications/consumer/en/5keys_en.pdf).

[4] WHO Guidelines on Hand Hygiene in Health Care.

ANNEX V

ANNEX ON BERRIES

INTRODUCTION

Berry crops are geographically diverse and represent a wide range of phenotypically unique fruits. Not only are they diverse in the size, shape and colours of their fruits, they are also diverse horticulturally, from low growing berries (e.g. strawberries), to small bushes (e.g. blackberries, blueberries, raspberries) and tall shrubs (e.g. blackcurrant and gooseberry). All are perennial but some are cultivated as annuals (e.g. strawberry); most are cultivated while others are collected from the wild (e.g. wild blueberries).

These fruits are relevant to international trade due to increasing consumption of fresh produce and globalization as a result of changes and/or optimization in production and distribution. There is increasing awareness on the risk factors associated with berry consumption on the part of public health officials. Berries have been associated with several foodborne illness outbreaks caused by a broad range of etiological agents, from viruses (Hepatitis A, Norovirus)[5], to bacteria (*E. coli* O26, O157:H7)[6,7] and protozoa (*Cyclospora cayetanensis*, *Cryptosporidium parvum*)[1].

Most berries are conveniently marketed as ready to eat fruits. The handling of berries during production and harvesting and the broad range of etiological agents that have been associated with berry consumption suggest that the safety of those fruits that are consumed raw is highly dependent on maintaining good hygienic practices along the food chain, including up to the point of consumption.

SECTION 1 - OBJECTIVES

Hygienic recommendations for the primary production of fresh fruits are covered in general under the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RCP 53-2003). The primary purpose of this Annex is to provide specific guidance to minimize microbiological hazards during primary production through packing and distribution of fresh berries, as well as fresh berries that are processed without a microbiocidal step (e.g. frozen berries eaten raw and ready-to-eat berries) and consumer use.

SECTION 2 - SCOPE, USE AND DEFINITIONS

2.1 SCOPE

This Annex covers specific guidance related to all areas, from primary production to consumption, of berries that are intended to be consumed raw (e.g., fresh berries) and/or are processed without a microbiocidal step.

This Annex encompasses all edible varieties of strawberries (i.e. *Fragaria* L), raspberries (i.e. *Rubus idaeus* L.), blackberries (i.e. *Rubus* spp.), mulberries (i.e. *Morus* L.), blueberries (i.e. *Vaccinium* spp.), currants and gooseberries (i.e. *Ribes* L.) and groundcherries (i.e. *Physalis peruviana* L.).

For wild berries only the measures for handling and post harvest activities (i.e. from Section 3.3.3 onwards) apply.

2.2 USE

This Annex follows the format of the *General Principles of Food Hygiene* (CAC/RCP 1-1969) and should be used in conjunction with it and other applicable codes such as the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RCP 53-2003), Annex I, the *Annex for Ready-to-Eat Fresh Pre-cut Fruits and Vegetables*, Annex II of the Guidelines on the Application of General Principles of Food Hygiene to the Control of Viruses in Food (CAC/GL 79-2012), the *Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables* (CAC/RCP 44-1995) and the *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CAC/RCP 8-1976).

2.3 DEFINITIONS

Refer to definitions in the *General Principles of Food Hygiene* and the *Code of Hygienic Practice for Fresh Fruits and Vegetables.*

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5 Report - Microbiological hazards in fresh fruits and vegetables of reference for an FAO/WHO Expert Consultation to support the development of commodity-specific annexes for the Codex Alimentarius.

6 Non-O157 Shiga toxin-producing *E. coli* (STEC) outbreaks, United States. CDC Foodborne Outbreak Online Database (2006)

7 Fresh Strawberries From Washington County Farm Implicated In *E. coli* O157 Outbreak In NW Oregon. At http://oregon.gov/ODA/FSD/strawberries.shtml (2011)

SECTION 3 - PRIMARY PRODUCTION

Berries are grown in production sites indoors (e.g. greenhouses) and outdoors, harvested, and may be field packed or transported to a packing establishment.

3.1 ENVIRONMENTAL HYGIENE

3.1.1 Location of the production site

Consideration of production site location should include an evaluation of the slope and the potential for runoff from nearby fields, flood risk as well as hydrological features of nearby sites in relation to the production fields. Growers should take measures to mitigate the risks associated with runoff and flooding, e.g. mapping the production field, terracing, construction of a shallow ditch to prevent runoff from entering the fields, etc.

The effects of some environmental events, such as heavy rains, cannot be controlled. For example, heavy rains may increase the exposure of berries to pathogens if soil contaminated with pathogens splashes onto fruit surfaces. Where appropriate, growers should take into consideration natural uncontrolled events, such as heavy rains and evaluate postponing harvesting berries for direct consumption berries and/or to subject the berries to a treatment that will minimise the risk from pathogens. The risk of contamination is greatest when heavy rains cause flooding and flood waters come in direct contact with berries; berries that have been contacted with flood waters should not be used.

Wet berries are very susceptible to spoilage and often resemble overripe berries leaking juice. Growers should allow a drying period, if possible, before harvesting berries to reduce the risk of contamination with foodborne pathogen.

The proximity of high risk production sites, such as animal production facilities, hazardous waste sites and waste treatment facilities, should be evaluated for the potential to contaminate production fields or the water sources used with microbial or other environmental hazards via, for example, runoff, faecal material, aerosols or organic waste. When the risks are high these production sites should not be used for berry production unless adequate measures can be taken to mitigate the risks.

3.1.2 Wild and domestic animals and human activity

Many wild and domestic animal species and humans that may be present in the production environment are known to be potential carriers of foodborne pathogens. Domestic and wild animals and human activity can present a risk both from direct contamination of the crop and soil as well as from contamination of surface water sources and other inputs. The following should be considered:

- Domestic and wild animals should be excluded from the production area, to the extent possible, using appropriate biological, cultivation, physical and chemical pest control methods. Methods selected should comply with local, regional, and national environmental protection regulations.
- Berry production areas should be properly maintained to reduce the likelihood of vector attraction). Activities to consider include efforts to minimize standing water in fields, restrict access by animals to water sources (may be based on local ordinances for public irrigation systems), and keep production sites and handling areas free of waste and clutter.
- Berry production areas should be evaluated for evidence of the presence of wildlife or domestic animal activity (e.g. presence of animal faeces, bird nests, hairs/furs, large areas of animal tracks, burrowing, or decomposing remains). Where such evidence exists, growers should evaluate the risks and whether the affected parcel of the berry production site should not be harvested for direct consumption.

3.2 HYGIENIC PRIMARY PRODUCTION OF BERRIES

Berries are pulpy fruits with high moisture content and a soft skin, which makes them susceptible to physical damage that accelerates deterioration of berries by increasing water loss and provide conditions for contamination during production, harvest and transport. Physical damage to the berries may occur during harvesting from the use of sharp edged storage containers, improper field packing or through careless and poor handling. Rodents, insects and birds may also damage berries, leading to increased microbial spoilage and the potential transmission of foodborne pathogens. Growers should take measures to reduce the extent of damaged fruits during production.

Some berries frequently contact soil directly during growth and/or harvesting. Bird droppings and airborne contaminants (birds nesting around the packing area, nearby livestock, poultry areas or manure storage or treatment facilities, etc.) may also pose a risk of contamination to berries. Growers should use production practices (e.g. site selection, wind breaks) to minimize the contact of berries with airborne contaminants and limit contact with the soil, animal droppings, soil amendments (including natural fertilizers) or direct contact with irrigation water .

Where materials are used under the berries during growing, to minimize contact with the soil, e.g. mulch or biodegradable materials (e.g. straw) or during harvest, e.g. plastic or biodegradable materials (e.g. leaves or papers as liners of biodegradable baskets), to collect harvested fruits, it is recommended that:

- Plastic should be clean and sanitary.
- If biodegradable materials and/or mulch are used, they should be applied only once and not reused in order to prevent cross contamination.

3.2.1.1 Water for primary production

Only clean water should be used for berry production. Growers should identify the sources of water used on the farm (municipality, re-used, irrigation water, reclaimed wastewater, discharge water from aquaculture, well, open canal, reservoir, rivers, lakes, farm ponds, etc.). Growers should assess and manage the risk posed by water as follows:

- Assessing the microbial quality of the sources of water used on the farm for the presence of pathogens should include a documented check detailing the potential for microbial contamination from all possible human and/or animal faecal sources of contamination (e.g. from animals, human habitation, leaks from sanitary facilities on field, sewage treatment, manure and composting operations) and the water's suitability for its intended use. In the case of identified contamination sources of the water used on the farm, corrective actions should be taken to minimize the risk of contamination. The effectiveness of corrective actions should be verified.
- Identifying and implementing corrective actions is a means to prevent or minimize contamination of water for primary production (e.g. settling or holding ponds that are used for subsequent irrigation and/or harvesting may attract animals or in other ways increase the microbial risks associated with water for irrigation). Possible corrective actions may include fencing to prevent large animal contact, proper maintenance of wells, filtering water, not stirring the sediment when drawing water, building settling or holding ponds, and water treatment facilities. If water treatment is needed, consult with water safety experts.
- Determine if microbial and chemical testing should be done to evaluate the suitability of water for each intended use. Analytical testing may be necessary after a change in irrigation water source, flooding or a heavy rainfall when water is at a higher risk of contamination. If testing, determine and document.
    - What tests need to be performed, (e.g. which pathogens and/or sanitary indicators)
    - Which parameters should be noted (e.g. temperature of water sample, water source location, and/or weather description),
    - How often tests should be conducted,
    - What the test outcomes indicate, and
    - How tests will be used to define corrective actions.
- Frequency of testing should depend on the source of the irrigation water (less for adequately maintained deep wells, more for surface waters) and the risks of environmental contamination, including intermittent or temporary contamination (e.g. heavy rain, flooding, etc.).
- If water testing is limited to non-pathogenic indicators, frequent water tests may be useful to establish the baseline water quality so that subsequent changes in the levels of contamination can be identified.
- If the water source is found to have unacceptable levels of indicator organisms or is contaminated with foodborne pathogens, corrective actions should be taken to ensure that the water is suitable for its intended use. Testing frequency should be increased until consecutive results are within the acceptable range.

Reassessment of the potential for microbial contamination is necessary when events or other conditions indicate that water quality may have changed.

3.2.1.2 Manure, biosolids and other natural fertilizers

The use of untreated manure and liquid manure should be avoided to the extent possible. Foodborne pathogens can persist in soil for long periods of time and as some berries have a short production cycle, they could become contaminated by pathogens in the manure.

Growers who are purchasing manure, biosolids and other natural fertilizers that have been treated to reduce microbial or chemical contaminants should obtain documentation from the supplier that identifies the origin, treatment used, tests performed and the results thereof. Growers may also evaluate the need to verify the information provided by the supplier on testing for contamination of natural fertilizer samples or auditing the composting process.

3.2.3 Personnel health, hygiene and sanitary facilities

Personal hygiene is critical with manual harvesting due to the amount of human handling that could lead to contamination of berries. Whenever possible, harvesting, packing and inspection processes should be designed to reduce fruit handling. All agricultural workers should properly wash their hands using soap and clean running water and dry their hands before handling berries, particularly during harvesting and post-harvest handling.

If gloves are used, a procedure for glove use in the field should be documented and followed. If the gloves are reusable, they should be made of materials that are easily cleaned and disinfected, and they should be cleaned regularly and stored in a clean area. If disposable gloves are used, they should be discarded when they become torn, soiled, or otherwise contaminated. Glove use alone is not a suitable substitute for good hand washing practices.

Where appropriate, each business operating primary production should have written Standard Operating Procedures (SOPs) that relate to health, hygiene and sanitary facilities. The SOPs should address worker training, facilities and supplies to enable agricultural workers to practice proper hygiene, and company policies relating to expectations for worker hygiene as well as illness reporting.

Non-essential persons, casual visitors and, to the extent possible, children, should not be allowed in the harvest area as they may present an increased risk of contamination.

3.2.3.1 Personnel hygiene and sanitary facilities

Growers should consider providing areas away from the field and packing lines for agricultural workers to take breaks and eat. For worker convenience, these areas should provide access to toilet and hand-washing facilities so that agricultural workers can practice proper hygiene.

As far as possible, sanitary facilities should be located close to the field and readily accessible to the work area.

- Sanitary facilities should be located in a manner to encourage their use and reduce the likelihood that agricultural workers will relieve themselves in the field. Facilities should be present in sufficient number to accommodate all personnel.
- Portable facilities should not be located or cleaned in cultivation areas or near irrigation water sources or conveyance systems. Growers should identify the areas where it is safe to put portable facilities.
- Facilities should include clean running water, soap, toilet paper or equivalent, and single use paper towels or equivalent. Multiple use cloth drying towels should not be used. Hand sanitizers should not replace hand washing and should be used only after hands have been washed.
- If clean running water is not available, an acceptable alternative hand washing method should be recommended by the relevant competent authority.

3.2.3.2 Health Status

The following should be considered:

- Growers should be encouraged to recognise symptoms of diarrhoeal or food-transmissible communicable diseases, and reassign agricultural workers as appropriate.
- Agricultural workers should be encouraged and, where feasible, be motivated with appropriate incentives to report symptoms of diarrhoeal or food-transmissible communicable diseases.
- Medical examination of agricultural workers should be carried out if clinically or epidemiologically indicated.

3.2.3.3 Personal cleanliness

When personnel are permitted to continue working with cuts and wounds covered by waterproof dressings, they should wear gloves to cover the bandages thereby providing a secondary barrier between them and the berries they handle or, otherwise they should be reassigned to another working area where they do not handle berries directly.

3.2.4 Equipment associated with growing and harvesting

Standard operating practices should be developed for the maintenance, cleaning and disinfecting operations of growing and harvesting equipment, which include the following:

- Containers used repeatedly during harvest should be cleaned after each load.
- Containers (including liners of containers made from biodegradable materials) that are no longer cleanable should be disposed of since they may increase the risk of microbial contamination of berries.
- Harvesting containers should not be placed directly on the ground.
- If the containers are stored outside, they should be cleaned and disinfected before being used to transport berries.

3.3 HANDLING, STORAGE AND TRANSPORT

Some berries may have high respiration rates making them more perishable. Enzymes and biochemical reactions play an important role in the ripening process but also accelerate spoilage of damaged fruits and increase susceptibility of berries to microbial contamination.

Growers should implement safe handling, transport and storage practices and immediately cool berries after harvesting. Precooling (i.e., rapid removal of field heat) berries after harvesting (e.g. within the first 2 hours) is important to maintain freshness and quality and contributes to the control of foodborne pathogens. When required, growers should use potable water for ice and hydrocooler when precooling to minimize risks of contamination.

- Manual harvest considerations:
  - Appearance and firmness of berries are commonly associated with fruit quality and freshness. Over handling the berries may damage and affect fruit quality. Moreover, adverse temperatures during

harvesting in hot and/or humid weather also decreases quality and may affect food safety due to fruit damage and juice leakage, which may spread contamination over healthy fruits.

- Growers should have a responsible person to supervise harvesting at all times to assure harvesters use proper hand washing and follow procedures not to harvest wet, bruised and/or damaged fruits. Additionally, berries that have fallen on the ground should be discarded unless they are processed with a microbiocidal step.
- Growers should take measures to train agricultural workers on safe handling, transport and storage practices to ensure that berries are immediately cooled after harvesting.

- Mechanical harvest considerations:
- Mechanical harvest is a common practice for some berries and may create food safety hazards if the equipment breaks down during the harvest, if it has received poor maintenance and cleaning or if it damages the fruit.
- Growers should avoid moving harvesting equipment across fields where manure or compost was applied.
- Before and after harvesting growers should perform proper cleaning and disinfection of all surfaces of equipments that have been in contact with berries. Moreover harvesting equipment should be cleaned and disinfected seasonally or as needed (e.g. if the equipment runs over an area with heavy animal intrusion and faecal deposits).

3.3.1 Prevention of cross-contamination

Specific control methods should be implemented to minimize the risk of cross-contamination from microorganisms associated with harvesting methods. The following should be considered:

- The extent of soil and extraneous matter debris on the fruit during and after harvesting may pose a risk of foodborne contamination. Growers should take measures to improve sorting and selection of berries.
- Harvest workers should not handle culled fruit in the field in order to prevent cross-contaminating healthy berries during harvest. It is recommended that culls be removed from the field by a worker who is not harvesting healthy fruit.
- Poor hygienic practices of agricultural workers in the field can significantly increase the risk of contaminating berries. In order to prevent microbial cross-contamination of berries, growers should continually reinforce the importance of good hygienic practices during pre-harvest, harvest and post-harvest activities.

3.3.3 Field packing

Preference should be given to the field packing into consumer ready containers of berries that will not be washed after harvest (e.g. strawberries), to minimize the possibility of microbial contamination through additional handling steps.

Growers should ensure that clean pallets and containers (disinfected where necessary) are used and take measures to ensure that the containers do not come into contact with soil and manure during field packing operations.

SECTION 4 – PACKING ESTABLISHMENT: DESIGN AND FACILITIES

Refer to the *General Principles of Food Hygiene* (CAC/RCP 1-1969) in conjunction with the *Guidelines on the Application of General Principles of Food Hygiene to the Control of Listeria monocytogenes* in *Ready-to-Eat Foods* (CAC/GL 61-2007).

4.1 LOCATION

4.1.2 Equipment

Whenever possible, equipment should be designed and placed to facilitate cleaning and disinfection, and to prevent build-up of biofilms that may contain foodborne pathogens of concern.

4.2 PREMISES AND ROOMS

4.2.1 Design and Layout

Premises and rooms should be designed to separate the area for incoming berries from the field (areas for incoming soiled and outgoing washed berries) from the area for handling. This can be accomplished in a number of ways, including linear product flow.

Where feasible, raw material handling areas should be separated from processing/packing areas. Within each of these areas, cleaning operations should be conducted separately to avoid cross-contamination between equipment and utensils used in each operation.

For products that are not immediately wrapped or packed (i.e. the berries are exposed to contaminants from the environment), the rooms where final products are packaged and stored should be designed and maintained to be as dry as possible. The use of water or having a wet environment enhances the growth and spread of foodborne pathogens.

Berry packing and/or processing establishments may be seasonal, and used for only a few months per year. The facilities may be dormant for many months, leaving them susceptible to pest infestations. Measures to minimize pest infestations should be put in place. The design should allow thorough cleaning and disinfection of food contact surfaces.

SECTION 5 - CONTROL OF OPERATION

Refer to the *General Principles of Food Hygiene* (CAC/RCP 1-1969) in conjunction with the *Guidelines on the Application of General Principles of Food Hygiene to the Control of Viruses in Food* (CAC/GL 79-2012) and the *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CAC/RCP 8-1976).

5.1 CONTROL OF FOOD HAZARDS

Prevention of contamination is a key control point for berries and packing establishments should pay special attention to product flow and segregation of incoming soiled and/or damaged and outgoing product to avoid cross-contamination.

Care should be taken to ensure that berries are not damaged and do not become cross-contaminated during transport and handling. Prior to packing, berries that are soiled, come with debris (e.g. insects), or that are damaged, should be inspected and culled.

Culled berries should be removed from the field or packing facility and disposed of to prevent contamination of other fruit. Culled fruit should be hygienically disposed of to avoid it from attracting pests.

5.2 KEY ASPECTS OF HYGIENE CONTROL SYSTEMS

5.2.2 Specific process steps

5.2.2.1 Post-harvest water use

Most berries intended for direct consumption are generally not washed after harvest.

For berries that are washed, clean or preferably potable water should be used. It is recommended that the quality of the water used in packing establishments be controlled and monitored, i.e. recording testing for indicator organisms and/or foodborne pathogens.

If water is used in pre-washing and washing tanks, additional controls (e.g. changing water whenever necessary and controlling of product throughput capacity) and monitoring (e.g. recording the pH and temperature, turbidity, and water hardness should be adopted.

Water used for final rinses should be of potable quality.

Any antimicrobial agents used in the water should be maintained at sufficient levels to ensure that water used in pre-washing and washing tanks does not act as a source of contamination for the fruit, and to prevent antimicrobial agents from damaging fruit skin structure.

If antimicrobials and/or disinfectants are used to control foodborne pathogens in post-harvest water, the efficacy of the treatment should be demonstrated/validated against a target organism under appropriate conditions (see Section 5.2.3).

5.2.3 Microbiological and other specifications

Microbiological testing can be a useful tool to evaluate and verify safety and the effectiveness of cleaning practices and to provide information about an environment, a process, and even a specific product lot, when sampling plans and methodology are properly designed and performed. The intended use of information obtained (e.g. evaluating the effectiveness of a sanitation practice, evaluating the risk posed by a particular hazard, etc.) can aid in determining what microorganisms are most appropriate to test for. Test methods should be selected that are validated for the intended use. Consideration should be given to ensure proper design of a microbiological testing programme. Trend analysis of testing data should be undertaken to evaluate the effectiveness of food safety control systems.

5.2.4 Microbial cross-contamination

Berries that have undergone cleaning and/or chemical treatment should be effectively separated, either physically or by time, from raw material and environmental contaminants.

Prevent cross-contamination between raw and washed berries, which will be frozen, from sources such as wash water, rinse water, equipment, utensils and vehicles.

Only workers who have been trained on hygienic handling should be assigned to pack berries.

5.3 INCOMING MATERIAL REQUIREMENTS

The following are recommended:

- For berries that are intended to be consumed raw as well as to be frozen**,** sorting and selection should be implemented to avoid using fruits that have visible signs of decay or damage due to the increased risk of microbial contamination.
- Berries should be cooled and stored as soon as possible under temperature controls within the processes.

5.7 DOCUMENTATION AND RECORDS

Where practicable, a written food safety control plan that includes a written description of each of the hazards identified in assessing environmental hygiene, as well as the steps that will be implemented to address each hazard, should be prepared by the business operating the primary production. The description should include, but is not limited to, the following: an evaluation of the production site, water and distribution system, manure use and composting procedures, personnel illness reporting policy, sanitation procedures and training programmes.

The following are examples of the types of records that should be retained:

- Microbiological test results and trend analyses
- Water monitoring and test results
- Storage room temperature levels
- Employee training records
- Pest control records
- Cleaning and disinfection reports
- Equipment monitoring and maintenance records
- Inspection/audit records

5.8 RECALL PROCEDURES

In the event of a foodborne illness outbreak associated with berries, maintaining appropriate records of production, processing, packaging and distribution may help to identify the source of contamination in the berry food chain and facilitate product recalls. Growers/packers/processors/distributors should consider developing and maintaining a traceability/product tracing system. The traceability/product tracing system should be designed and implemented according to the principles for *Traceability/Products Tracing as a Tool within a Food Inspection and Certification System* (CAC/GL 60-2006), especially to enable the withdrawal of the products, where necessary.

Detailed records should be kept that link each supplier of the product with the immediate subsequent recipient of the berries throughout the food chain. The information needed to link each supplier should include, if available, the packer name, address, and phone number, date packed, date released, type of berry (e.g. strawberry, blueberry, etc.) including brand name, lot identification and number of lots, and transporter.

SECTION 6 – ESTABLISHMENT: MAINTENANCE AND SANITATION

6.1 MAINTENANCE AND CLEANING

6.1.1 General

Food contact surfaces should be cleaned and disinfected before the start and throughout the season of the specific fruit to ensure microbial pathogens do not become established in the facility or on the equipment.

6.1.2 Cleaning procedures and methods

Written SOPs should be developed and implemented for the cleaning and disinfection of equipment used for post-harvest treatment.

SECTION 8 – TRANSPORTATION

Refer to the *Code of Practice for the Packaging and Transport of Fresh Fruits and Vegetables* (CAC/RCP 44-1995).

SECTION 9 – PRODUCT INFORMATION AND CONSUMER AWARENESS

9.4 CONSUMER EDUCATION[8]

The following should be considered:

- All stakeholders – government, industry, consumer organizations and the media – should work together to communicate clear consistent messages on handling berries safely to avoid giving contradictory advice and causing confusion.

Consumer information on handling berries safely should cover:

- Avoiding the purchase of trays or cases with damaged or rotten berries.
- Transporting to home. Increase in product temperature during transportation can be considerable.
- Storage/ refrigeration of berries. Berries should preferably be stored in a cool environment. All prepackaged berries should be refrigerated as soon as possible.

8 "The WHO Five Keys to Safer Food" message and its supporting materials offer simple and clear guidance for food handlers including consumers on safe food handling (http://www.who.int/foodsafety/publications/consumer/en/5keys_en.pdf).

- Once removed from the refrigerator, berries should be consumed as soon as possible.
- Correct hand washing methods[9].
- Cross-contamination. Consumers need to handle, prepare, and store berries safely to avoid cross-contamination with foodborne pathogens from various sources (e.g. hands, sinks, cutting boards, utensils, raw meats).
- The need to wash berries with potable water before consuming.

SECTION 10 – TRAINING

10.2 TRAINING PROGRAMMES

Since producing berries for direct consumption is labour intensive, which increases the risk of contamination from manipulation, special attention is needed to properly select and train all personnel involved in primary production, packing, processing or transport operations of berries that are intended to be consumed.

Growers should train personnel to ensure that only experienced pickers harvest berries that are intended for direct consumption.

All agricultural workers should receive training appropriate to their tasks and should be periodically assessed while performing their duties to ensure tasks are being completed correctly.

Specific employee training programmes should include the following:

- The importance of sorting out berries with visible defects, such as broken skin, decay, mould, soiled and insect and/or bird damaged fruit.
- Agricultural workers should be trained to follow the SOPs .
- Training and supervision of the agricultural workers is essential to the success of any harvesting operation.
- Training should be provided and reinforce for agricultural workers on good hygienic practices relevant to the growing, harvesting and post harvesting activities of berries. Poor hygienic practices can significantly increase the risk of the microbial contamination.
- The importance to minimize post harvest handling, thereby increasing the shelf life and safety of the berries.
- The importance of recognizing and recording field contamination indicators (e.g. broken fences, animal droppings, high incidence of insects) and taking appropriate measures to mitigate the risks.
- The importance of proper berry handling techniques to minimize or prevent damage to the fruit and microbial contamination.
- The importance of proper use of hygienic facilities. Training could include, for example, toilet use, proper disposal of toilet paper or equivalent, and proper hand washing and drying procedures.
- Training in cold chain logistics and management, in line with advancing knowledge and technologies for both refrigeration and temperature monitoring and expanding international trade.

Training should be delivered in a language and manner to facilitate understanding of what is expected of them and why, and should emphasize the importance of using hygienic practices. A well-designed training programme considers the barriers to learning of the trainees and develops training methods and materials to overcome those barriers.

Training programmes should be repeated periodically, and updated whenever there is a change in the product, process or staff and monitored for effectiveness and modified when necessary.

Appropriate training records should be kept.

9 WHO Guidelines on Hand Hygiene in Health Care **(WHO, 2009), Part II.2. Hand hygiene technique**: http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf