Guidelines for On-Farm Food Safety for Fresh Produce



Second Edition

national FOOD industry strategy

HAL
Know-how for Horticulture™

Australian Government
Department of Agriculture, Fisheries and Forestry

Department of Agriculture, Fisheries and Forestry

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Acknowledgments

The Australian Government Department of Agriculture Fisheries and Forestry (Department) and Horticulture Australia Ltd (HAL) would like to thank the following people for their contribution to this, the second edition of the Guidelines for On-Farm Food Safety for Fresh Produce:

- Joseph Ekman, NSW Department of Primary Industries
- Clare Hamilton-Bate, Freshcare Limited
- Scott Ledger, Department of Primary Industries and Fisheries, Queensland
- Helen Lipton, Helen Lipton & Associates
- Jane Lovell, Tasmanian Quality Assured Inc.
- Graham McAlpine, McAlpine Management Services Pty Ltd
- Robert Premier, Agriculture Victoria
- Richard Bennett, Horticulture Australia Ltd
- Justin Fromm, Australian Government Department of Agriculture, Fisheries and Forestry

In addition, the horticulture industry was widely consulted for its views and opinions. Many people provided useful comments on its up-dated content and design. The following are particularly acknowledged for their valuable contribution:

- Elizabeth Frankish, Microserve Laboratory Pty Ltd, WA
- Walter Collins, Trial Bay Quality Assurance
- Daryl Stevens, Co-Ordinator of Reclaimed Water Development in Horticulture

This publication has been developed as part of the National Food Industry Strategy
Food Safety and Quality Assurance Initiative

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ISBN 0642 53967 7

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1 – Introduction

1.1 Background to the guidelines

The proliferation of food safety and quality assurance (QA) schemes in Australia's agriculture and food sectors is widely recognised and new systems, schemes and codes of practice continue to emerge. The burgeoning number of systems and associated audits is presenting some significant challenges to industry. Confusion, high compliance costs, duplication and inconsistencies in the way food safety and QA systems are being implemented and audited are common concerns.

In 1999, the then Commonwealth Minister for the Australian Government Department of Agriculture, Fisheries and Forestry, the Hon Warren Truss, MP, recognised the seriousness of this issue and its potential to undermine the integrity of Australian food and to impede industry competitiveness. As a result he established a joint government-industry working group called the *Working Group on Safety and Quality Systems' Equivalence*[1].

The need for guidelines to enable greater consistency in the way in which horticultural food safety programs are implemented and audited was first raised during a Working Group project titled, Case Studies as Demonstration Models for Achieving Equivalence[2]. Considerable uncertainty and confusion existed (and still exists) in horticultural industries with regard to some of the technical aspects for on-farm food safety.

The original *Guidelines for On-Farm Food Safety for Fresh Produce* was created under the auspices of the Working Group to address these issues and to provide a single, consolidated source of information relating to on-farm food safety for fresh produce crops. It covers the growing, harvesting, packing, storage, and dispatch stages of production. Fresh produce includes fruit, vegetables, herbs, and nuts supplied for sale to customers in the wholesale, retail, and food service sectors or for further processing.

The guidelines are designed for use by growers, packers, auditors, trainers, facilitators, consultants and customers to achieve greater certainty and consistency in the development, implementation and auditing of on-farm food safety programs. Other parties, however, with an interest in food safety issues in the fresh produce sector may also find the guidelines to be of interest and value.

[1] The Working Group on Safety and Quality Systems' Equivalence chaired by the Department included membership drawn from Food Standards Australia and New Zealand (FSANZ), the Australian Quarantine and Inspection Service (AQIS) and industry members representing different industry sectors and links in the food chain, including primary industries, processed food, retail and food service sectors. Contact the Department: phone 02 6272 5671.

[2] This Australian Government Department of Agriculture, Fisheries and Forestry-commissioned project sought to achieve more cost-effective food safety and quality arrangements at five selected Australian food businesses by minimising duplication, inconsistencies and inefficiencies caused by multiple safety/quality systems and compliance requirements at each business.

1.2 How the guidelines were developed

The first issue (2001) was developed by a working group of government/industry representatives to address the need for greater consistency in implementing and auditing food safety programs in the fresh produce sector. It was based on a review of audit checklists used to guide food safety audits of Australian horticultural businesses against the actual requirements of the various food safety systems and audit companies.

This second issue of the Guidelines includes up-to-date information about emerging issues that are of importance to on-farm food safety programs. The most recent scientific reference material has been used to update the guidelines. The most noticeable addition of new information is provided in Chapter 5, 'Assessing the Risk of Contamination' and in Chapter 6, 'Testing Information (including soil testing)'.

The following documents, in particular, were key reference sources:

- *Strategies for the Safe Use of Poultry Litter in Food Crop Production*, K. Wilkinson, Agriculture Victoria, September 2003
- *Foodborne Microorganisms of Public Health Significance*, AIFST (NSW Branch, Food Microbiology Group) 6th edition, 2003
- *Guidelines for the Management of Microbiological Food Safety in Fruit Packinghouses*, Department of Agriculture, Western Australia, 2002.
- *Improving the Safety and Quality of Fresh Fruit and Vegetables: A Training Manual for Trainers*, JIFSAN, University of Maryland, USA, 2002
- *Workbook, Approved Supplier Requirements for Fresh Produce Short Course*, Murrumbidgee College, NSW Agriculture and Department of Primary Industries Queensland, 2001
- *Freshcare Code of Practice, On-Farm Food Safety Program for Fresh Produce*, Freshcare Ltd, 2000
- *Guidelines for Interpretation of the SQF 1000CM Quality Code in Australian Horticulture*, Agwest Trade and Development, 2000
- *Guidelines for Drinking Water Quality*, World Health Organisation, 2000
- *Australian Soil Fertility Manual*, Fertilizer Industry Federation of Australia (Pub) CSIRO, 1999
- *Draft Code of Practice for the Primary Production, Harvesting and Packaging of Fresh Fruits and Vegetables*, Codex Alimentarius Commission, 1999
- *Guide to Minimize Microbiological Food Safety Hazards for Fresh Fruits and Vegetables*, USDA, 1998
- *Guidelines for Sewerage Systems – Biosolids Management*. Agriculture and Resource Management Council of Australia and New Zealand. Water Technology Committee. Occasional Paper WTC No 1/95. October 1995
- *Australian Water Quality Guidelines for Fresh and Marine Waters*, Agriculture and Resource Management Council of Australia and New Zealand, 1992
- *Safe Vegetable Production: A Microbial Food Safety Guide for the Australian Vegetable Industry*, Institute for Horticultural Development, Victorian Department of Natural Resources and Environment, 2002.

In developing these guidelines, every effort has been made to engage those with expertise in food safety relating to the fresh produce industry. It is recognised that the information contained in these guidelines will need to be regularly updated to reflect increasing understanding of the issues and risks associated with fresh produce. Feedback and suggestions for improvement on the guidelines are welcomed and can be directed to the Department at foodinfo@daff.gov.au.

2 – How to use the guidelines

2.1 Scope of the guidelines

These guidelines are designed to assist growers, packers, auditors, trainers, consultants and others to assess the risk of food safety *hazards* occurring on farm during the production of fresh produce crops. Some information is provided on good agricultural practices (GAPs) that may assist in *preventing, reducing, or eliminating* the hazards. The practices have been identified from industry food safety programs based on the Hazard Analysis and Critical Control Points (HACCP) method.

Hazard
A food safety hazard is any microbiological, chemical, or physical substance or property that can cause fresh produce to become an unacceptable health risk to consumers.

Fresh produce production
Fresh produce includes fruit, vegetables, herbs and nuts, and production covers the growing, harvesting, ripening, packing, storage and despatch of produce to customers. Production includes traditional growing in soil as well as hydroponic operations. These Guidelines ***do not apply to*** high risk fresh produce categories, such as sprouted seeds and freshcuts (minimally processed fruits and vegetables).

Genetic modification
Genetic modification is defined as the process of copying and transferring a single genetic trait between species, without the use of natural reproductive processes. Genetically modified crops are outside the scope of this publication, and it is recommended that reference be made to the Interim Office of the Gene Technology Regulator for more information (www.health.gov.au/tga/genetech.htm).

2.2 Guideline sections

Section 3 – Food safety hazards associated with fresh produce

This section is designed to improve awareness and knowledge about the most common potential hazards and possible causes of contamination. There are three major categories of food safety hazard – *microbiological, chemical*, and *physical*. Contamination of produce can occur *directly* through agricultural practices, or *indirectly* through produce contacting contaminated surfaces or substances.

Section 4 – Process steps and inputs

Process flow diagrams are presented for the major stages of growing the crop, field packing and shed packing. The diagrams provide a guide to the range of steps that may occur and for each step the inputs that could introduce a food safety hazard. Local on-farm information and experiences can be used to strengthen these processes.

Section 5 – Assessing the risk of contamination

In order to assess the risk of contamination, each business needs to identify the process steps and inputs that are relevant to the particular crops grown on-farm. This will act as a guide to analysing where food safety hazards may occur and thereby assess the risk of contamination. Good agriculture practices will help to prevent, reduce or eliminate the occurrence of hazards (see Appendix 2) and support safe food production.

There are *four inputs* in particular where the risk of contaminating the produce varies considerably with the type of produce and the specific input used – *soil, fertilisers and soil additives, water, and people*. The soil may be a cause of contamination from persistent chemicals and heavy metals. Fertilisers, soil additives and water may be a cause of microbiological and chemical contamination. People may be a cause of chemical, microbiological and physical contamination. Mention is made of allergenic agents both naturally occurring and introduced, but a more detailed risk analysis is beyond the scope of this publication.

This section provides information to help understand why the risk of contamination varies for these inputs and decision guides are presented to assess whether a significant risk exists. Some of the decision guides contain *critical limits*, which are based on research, professional advice, legislative requirements and other guidelines.

Section 6 – Testing Information (including soil testing)

The requirement for chemical and microbiological testing of fresh produce is an area of significant debate and uncertainty. It is important to verify effective control of the potential hazards on-farm that may cause a risk to human health. This section presents information on *what* to test for, *how often* to test, and sampling *methods* to help standardise the approach to testing. Some information on soil testing is also included.

Appendix 1 – Microbiological risk categories

A reference table classifying fresh produce crops into three broad *microbiological risk categories* is presented. Produce is assigned to the risk categories according to their growing characteristics and final use by consumers (eaten uncooked or peeled or cooked before eaten). The categories are meant as a guide only, and should not be taken as absolute assessments of microbiological risk.

Appendix 2 – Review checklist – good agriculture practices

The review checklist identifies the good agricultural practices that should be addressed in on-farm food safety programs for fresh produce. The checklist is divided into sections according to the *potential causes of contamination*. The practices have been identified from industry food safety programs based on the Hazard Analysis and Critical Control Points (HACCP) method.

How to use
The checklist can be used as an easy reference for internal audits carried out by individual businesses, or to supplement existing audit checklists used by certification bodies. As with any generic checklist, some items may not be considered relevant and may be excluded, and others may need to be added.

3 – Food safety hazards associated with fresh produce

It is important to identify and assess all possible food safety hazards on-farm, no matter how high the standard of operations, and even if no perceived potential risk exists. The hazards can be broadly divided into three categories: *microbiological, chemical, and physical*.

The following table lists the potential hazards for each category and possible causes of contamination. Contamination of produce can occur directly through agricultural practices, or indirectly through produce contacting contaminated surfaces or substances.

Type of hazard	**Hazard**	**Cause of contamination**
Microbiological **Note:** There are many microorganisms in the environment – some are totally harmless, some are beneficial, such as those used in yoghurt and cheese-making, and others are the cause of food spoilage and rotten fruit and vegetables. Only a very small number of microorganisms are harmful to humans. These are called *human pathogenic microorganisms* and are the causes of human disease. Examples include species of bacteria, such as *Salmonella* and *Listeria* and viruses, such as Hepatitis A.	Micro-organisms (microbes) on produce in population numbers that may cause food-borne illness in susceptible consumers - bacteria - viruses - parasites - algae - fungi	- faeces from or the remains of wild and domestic animals and human sewage contaminating water used for irrigating, pesticide application, harvesting, unloading, washing, top icing, hydro-cooling, cleaning - untreated organic animal products used for fertilising and soil improvement contacting produce directly or indirectly via the soil - picking produce that contacts or drops on to contaminated soil - inadequate cleaning of picking containers and harvesting, grading and packing equipment contaminated by soil, decaying matter and faeces of rodents, birds and insects - stacking of pallets, crates and bins contaminated with soil and faeces on top of exposed produce - packaging and packing material contaminated with faeces from rodents, birds and insects - handling of produce by infectious workers due to inadequate toilet and hand washing facilities, poor personal hygiene practices, and sickness (e.g. communicable diseases such as hepatitis A) - leakage of contaminated water from recirculating cooling systems in cold rooms

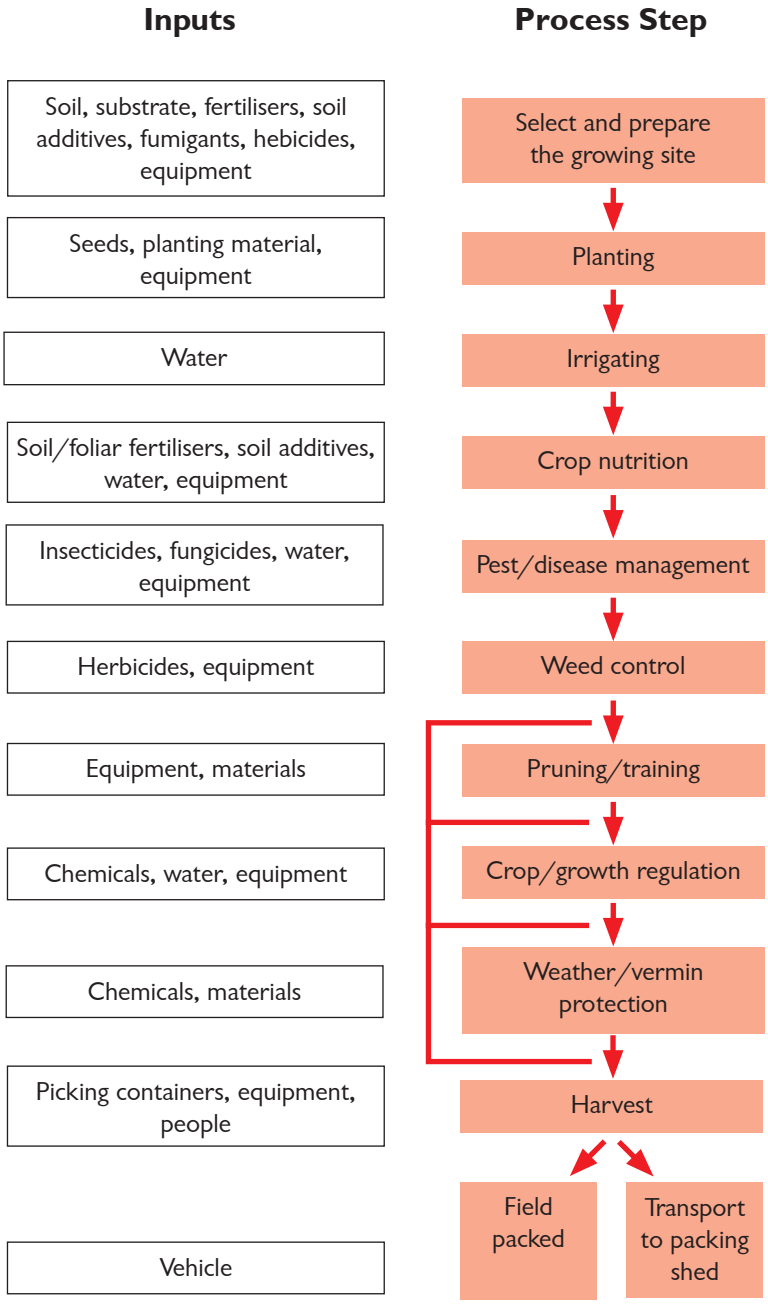
Type of hazard	Hazard	Cause of contamination
Chemical	Pesticide residues in produce exceeding maximum residue limits (MRLs). **Note:** pesticides that are not registered or approved for use on specific produce (with permits) have a zero MRL	- not reading/understanding the pesticide label - incorrect advice - incorrect mixing — concentration higher than label rate - withholding period not observed - equipment incorrectly or not calibrated - spray drift from adjacent crop - pesticide in soil from previous use - pesticide residue in picking bins, crates - equipment not cleaned after use - multi-purpose use of equipment — for example, both washing and spraying - dumping, accidental spillage or seepage of pesticide into soil or water source
	Heavy metal residues in produce exceeding maximum levels (MLs)	- continued use of fertilisers with high levels of heavy metals - high levels of heavy metals present in the soil, naturally or due to previous use - development of soil conditions conducive to uptake of heavy metals by crops e.g. acidity, salinity, zinc deficiency
	Natural toxins	- unsuitable storage conditions — for example, storage of potatoes in light - peanuts, tree nuts and all their products
	Non-pesticide chemical contamination	- chemical and fertiliser spills on pallets - leakage of chemicals and fertilisers transported with produce - oil leaks and grease on equipment in contact with produce - spillage of chemicals (e.g. vermin control chemicals) near produce or packaging materials - use of inappropriate cleaning chemicals - residues in picking containers used to store chemicals, fertiliser, oil etc
	Allergenic Agents - traces of a substance which may cause a severe reaction in susceptible consumers (eg asthmatics, immune-repressed)	- Sulphur dioxide (e.g. desiccation pads used on grapes)

Type of hazard	Hazard	Cause of contamination
Physical	Foreign objects from the environment (e.g. soil, stones, sticks, weed seeds)	- harvesting of ground crops during wet weather - dirty harvesting and packing equipment - dirty picking containers and packing materials - stacking of dirty pallets, crates and bins on top of exposed produce
	Glass	- broken lights above packing equipment and areas where produce is exposed - broken bottles picked up by harvesting equipment — left by workers or thrown into block from passing traffic
	Foreign objects from equipment and containers (e.g. wood splinters, metal shavings, plastic objects, paint flakes)	- damaged picking containers, harvesting and packing equipment and pallets - inadequate cleaning after repairs and maintenance - workshop areas too close to packing and storage areas - shotgun pellets
	Foreign objects from human handling (e.g. jewellery, adhesive dressings, gloves)	- careless or untrained staff - inappropriate clothing

4 – Process steps and inputs

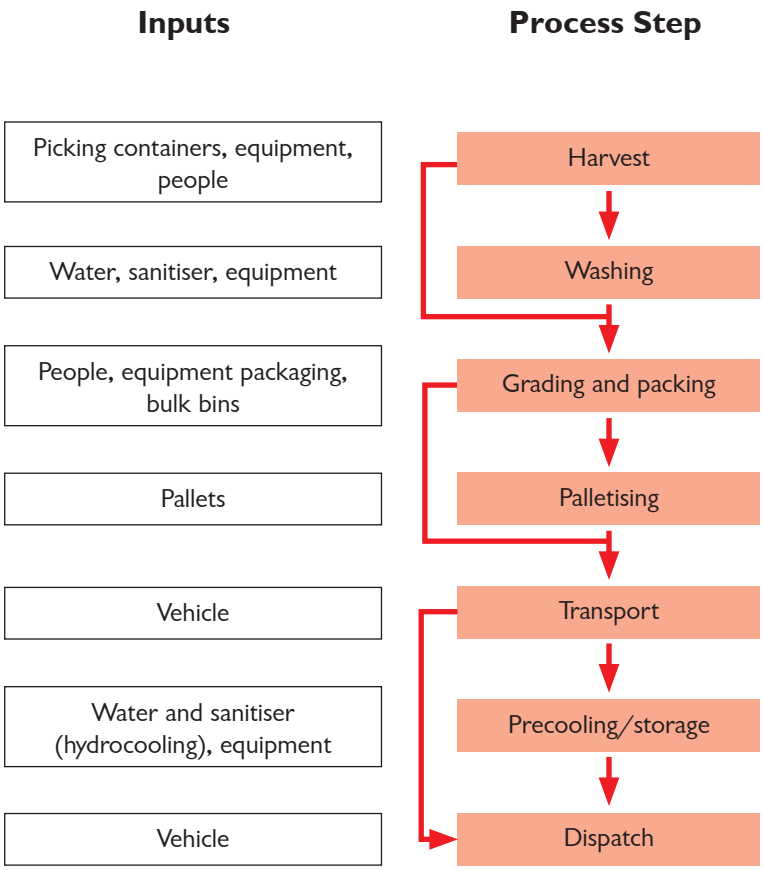
4.1 Growing the crop – process flow

The diagram shows a flow of steps that may occur during the growing crops in the ground and the inputs that could introduce a food safety hazard. In practice the steps do not follow a set order after planting and some steps are not required for all crops. For hydroponics, the nutrient solution and the root support medium are extra inputs.



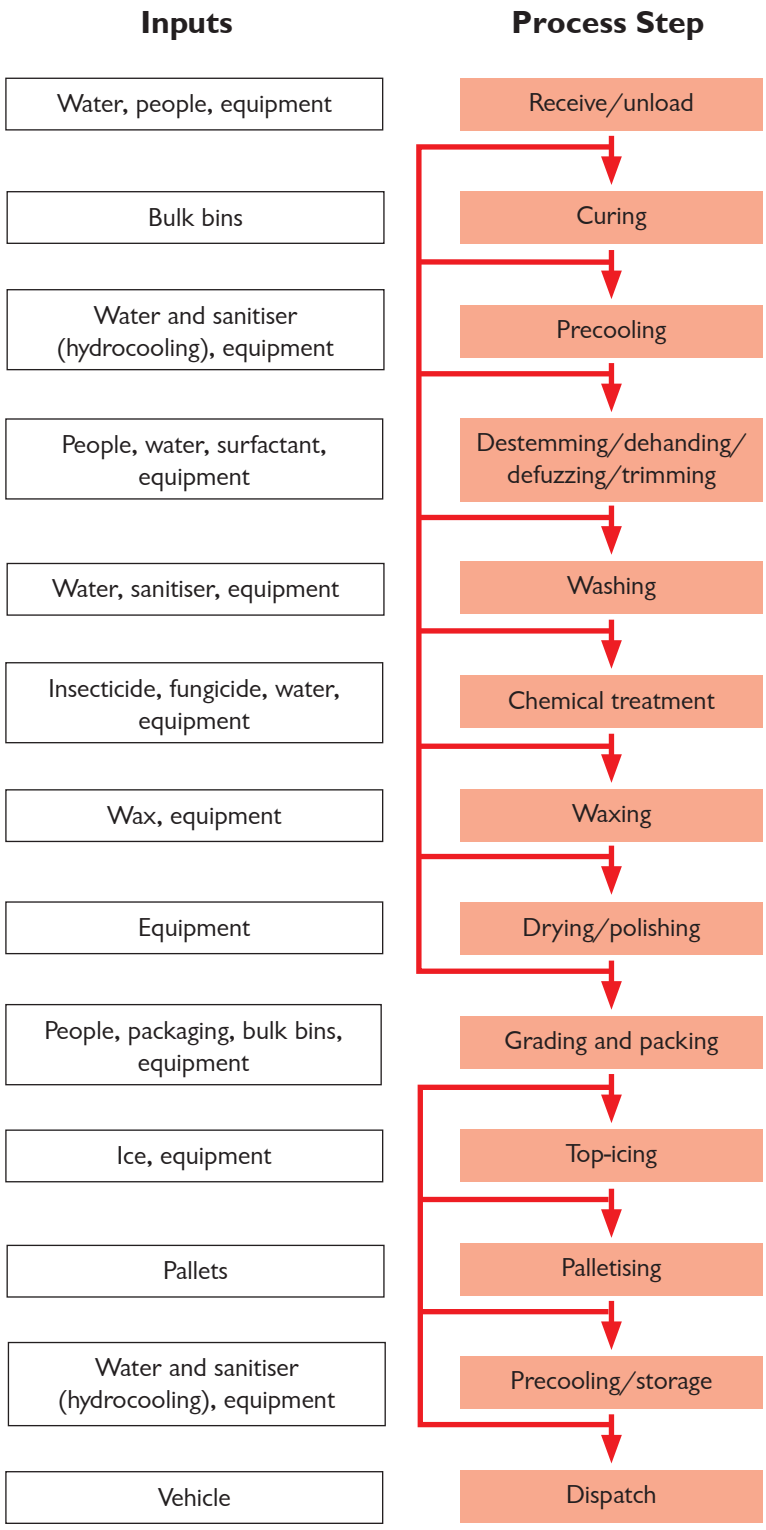
4.2 Field packing – process flow

The diagram shows a flow of steps that may occur during field packing of fresh produce and the inputs for each step that could introduce a food safety hazard. Some steps are not required for all crops. For example, some crops are not washed before packing and others are not pre-cooled before despatch.



4.3 Shed packing – process flow

The diagram shows a flow of steps that may occur during shed packing of fresh produce and the inputs for each step that could introduce a food safety hazard. The order and presence of steps varies with crops.



5 – Assessing the risk of contamination

It is important to *demonstrate* that all possible food safety hazards on-farm have been assessed, no matter how high the standard of operations, and even if no perceived potential risk exists. Each business needs to identify the process steps and inputs that are relevant to the crops grown. The HACCP (Hazard Analysis and Critical Control Points) approach has been widely adopted as a food safety tool, to identify where food safety hazards may occur, just how serious they could be, and how to prevent or minimise the risk of contamination.

Good agricultural practices help to prevent, reduce or eliminate the occurrence of hazards (see Appendix 2 – Review checklist) to ensure that fresh produce is fit for consumption.

In order to assess the potential risk to human health, consideration must be given to the different possible sources of contamination. There are four input areas in particular where the risk of contaminating the produce varies considerably with the type of produce and the specific inputs used – soil, fertilisers and soil additives, water and people. The soil may be a cause of contamination from persistent chemicals and heavy metals. Fertilisers, soils additives and water may be a cause of microbiological and chemical contamination. People may be a cause of microbiological, physical and chemical contamination.

5.1 Contamination from chemicals

Persistent chemicals in the soil

One important issue to review is the possible contamination by chemicals that have been used in the past and remain in the soil. *Persistent* chemicals belonging to the organochlorine (OC) and organophosphate (OP) groups may be present on farms due to past use, dumping or spillage. As well as application to previous crops, 'hot spots' such as old dip sites, disposal or dumping areas, remnant building sites and areas near power poles may be present. How long chemicals remain in the soil will depend on soil type, climatic conditions and how the chemicals were used (e.g. cover spray, dip, dump site).

In Australia, dieldrin is a common example of a persistent chemical. Dieldrin is an insecticide that belongs to the organochlorine group. Although dieldrin has not been legally used since the 1980s, it was once applied routinely as an agricultural, industrial and domestic insecticide for the control of termites (white ants), household pests, ants and soil insects.

Paddock history is important in assessing the risk from dieldrin residues. Areas used to grow sugar cane, sweet corn, some vegetable crops and orchard crops have the highest risk of being contaminated. In paddocks assessed as being a risk, soil testing should be undertaken to determine whether residues are present or not. Soil contamination of growing sites can lead to contamination of produce.

It should be noted that the amount of chemical in or on the produce is more important than how much is in the soil.

The risk of contamination is higher for root and tuber vegetables and crops grown near or in contact with the soil, as persistent chemicals can be present in soil on the produce surface. For crops grown above the ground, the risk of contamination is low, as only minute amounts of chemical may be taken-up through root absorption. Avoiding the picking of fallen produce (e.g. windfall fruit) will prevent surface contamination.

Residual chemicals on produce

The distinction needs to be made between *persistent* chemicals found in the soil, as described above, and *residual* chemicals, which are chemicals remaining on produce from;

a) post-harvest treatments to preserve shelf-life e.g. fungicides, or
b) chemicals (insecticide, fungicide, herbicide) used in on-farm chemical spray programs.

Maximum Residue Limits

The maximum residue limit (MRL) is the *maximum concentration of a residue that is legally permitted* on produce after harvest. Food Standards Australia New Zealand (FSANZ, website www.fsanz.gov.au, phone 02 6271 2222) sets the MRLs permissible in or on a food, agricultural commodity or animal feed. FSANZ has established MRLs for fresh produce, which are published in the Food Standards Code, Section 1.4.2.

When produce is being exported to another country, a check of the appropriate importing country MRLs should also be undertaken.

Extraneous Residue Limits
An Extraneous Residue Limit (ERL) is the maximum permitted level of a pesticide residue, arising from environmental sources other than the use of a pesticide directly or indirectly on the food. For example, dieldrin has no registered use, and application to crops or pastures is no longer legal. Therefore any dieldrin residue detected on produce is assumed to arise from an environmental source.

Exceeding the Legal Limits
Residues detected exceeding the MRL are unacceptable, but do not necessarily represent a hazard to consumers because of the high safety margins used to set the standards.

Where an MRL or ERL does not exist, *no residues are permitted in the produce*.

If chemical residue testing of produce identifies levels of OC/OP chemicals above the MRL/ERL, isolate the crop and take measures to either dispose of the crop or reduce the residue level to an acceptable level. *Do not sell produce with chemical residues above a MRL/ERL or feed the crop to livestock*. If the residue is present in soil or dust on the produce surface, washing may reduce the residue to an acceptable level.

Avoid growing produce on or adjacent to sites where OC/OP chemicals have been recently detected in the soil or in previous crops. Alternatively, grow a crop which has no direct soil contact with the edible part.

Allergenic Agents

Allergenic agents are traces of a substance that may cause a severe reaction in susceptible consumers (e.g. asthmatics, immune-repressed). They may be naturally occurring toxins, such as those produced by fungi, or be introduced during production. An assessment should be made about final destination of fresh produce, given the sensitivity of some consumers.

Naturally occurring toxins
The most important fungi causing toxic effects in humans and animals are the species that produce aflatoxins. These fungi (*Aspergillus spp.*) have a particular affinity for nuts and oilseeds, particularly peanuts, corn and cottonseed[1]. In general, control of aflatoxins relies on screening techniques, such

[1] Food Standards Code, Food Standards Australia New Zealand, Food Standards Code 1.4.1 and 1.4.2 Schedule 3.

as:

a) examination under UV light for corn, cottonseed and figs, or
b) electronic colour sorting of peanuts.

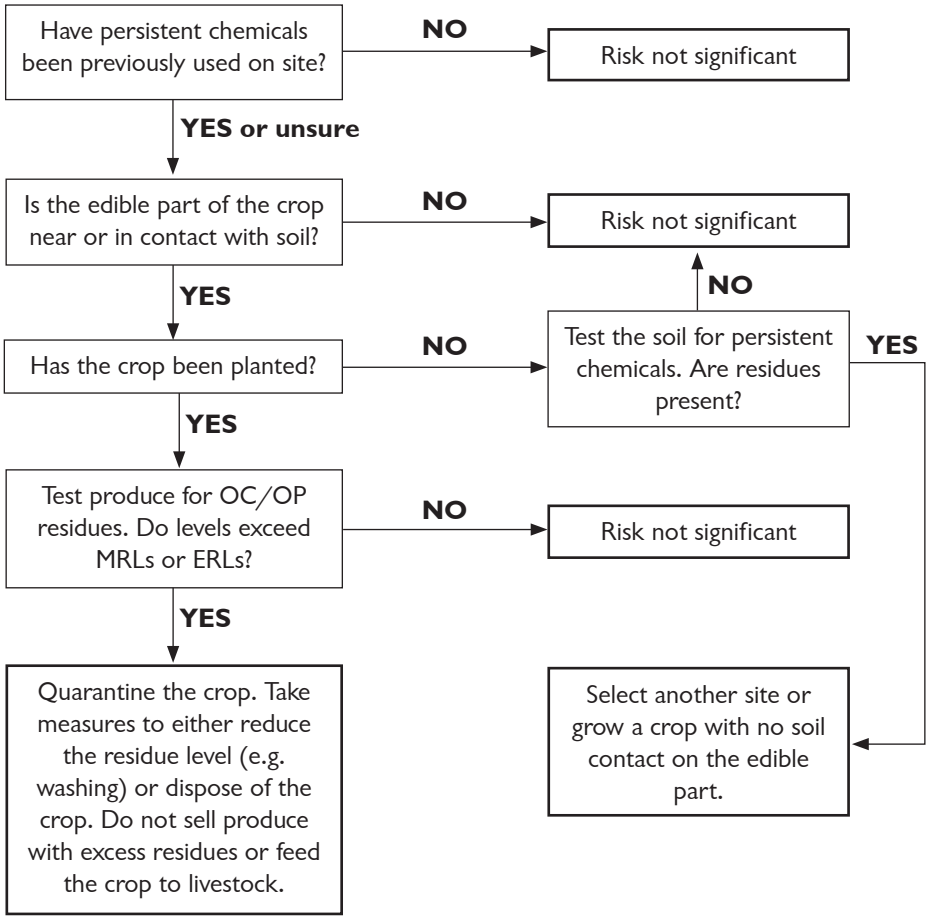
Aflatoxins are the first mycotoxins covered by legislation. Australian regulations permit 15 ug/kg total aflatoxins in peanuts and treenuts[1], but no statutory limits have been specified for other foods. The most effective means of controlling aflatoxins in commodities is to prevent the plants from becoming infected with aflatoxigenic strains of fungi.

Chemical toxins

The most important issue relevant to the fresh produce industry is the use of sulphur dioxide (SO_2) pads in packed/stored grapes. The pads are designed to slowly release SO_2 in the high humidity atmosphere within the plastic-lined package to control fungal spoilage organisms that often affect stored grapes. Asthmatics have been known to be particularly sensitive to SO_2, and the best strategy is to use a clearly visible printed warning statement e.g. under Australian labelling laws: *"Preservative 220 in use"*.

[1] Food Standards Code, Food Standards Australia New Zealand, Food Standards Code 1.4.1 and 1.4.2 Schedule 3.

Decision guide for assessing the risk of chemical contamination from persistent chemicals in the soil.



Note: Identify and quarantine potential 'hot spots' such as old dip sites, disposal or dumping areas, remnant building sites or near power poles. Avoid these areas for growing fresh produce.

5.2 Contamination by heavy metals

Heavy metals are the group of metals with a specific gravity of five or higher, meaning they are five or more times heavier than water. Examples are cadmium, lead and mercury. Heavy metals may occur naturally in soils or they can be introduced in small amounts through the use of fertilisers (especially phosphate) and soil additives (such as gypsum and animal manure), and from industrial uses (either past or present).

Maximum levels (MLs) are specified for cadmium and lead in fresh produce in the Food Standards Code. Cadmium is the heavy metal of most concern to fresh produce. Lead is unlikely to pose a food safety risk, because it is highly immobile in soils, with very little taken up by plants.

Most cadmium occurring naturally in the soil is present at levels of 0.1-1.0 mg Cd/kg of soil[1], and is in an insoluble form, so uptake by plants is low. Cadmium is mobilised and uptake increases where soils are very sandy, saline or acidic, low in zinc or organic matter, and if irrigation water is salty.

The potential risk of cadmium uptake varies with the type of produce. The risk is higher for the following produce:

- Root and tuber vegetables;
- Leafy vegetables (e.g. chinese cabbage, lettuce, spinach, silver beet); and
- Peanuts.

These higher-risk crops should be tested for cadmium levels if conditions favour uptake. If the residue level is less than half the legal limit, retest every three years. If the level is greater than half the legal limit, retest every year. If the level exceeds the legal limit, use an alternative site or modify practices/conditions to minimise uptake. For example, change the source of the irrigation water if the water is salty, or use fertilisers made from phosphate rock with low cadmium content (less than 100 mg Cd/kg P).

Food Standards Australia New Zealand (FSANZ, website www.fsanz.gov.au or phone 02 6271 2222) has established acceptable limits for the presence of heavy metals in foodstuffs, and published information on maximum levels (MLs) for fresh produce is contained in the Food Standards Code, Section 1.4.1. Where produce is being exported to another country, a check of the appropriate importing country MLs should also be undertaken.

[1] *Australian Soil Fertility Manual*, Fertilizer Industry Federation of Australia (Pub) CSIRO, 1999

5.3 Contamination from fertilisers and soil additives

Chemical contamination

Chemical contamination of fresh produce can be caused by the presence of cadmium in fertilisers (especially phosphate and some trace element mixes) and soil additives such as gypsum, animal manures, biosolids and composts. Root and tuber crops and leafy vegetables can take up cadmium if growing conditions are favourable for uptake (see 5.2 Heavy metals). For other crops there is minimal risk of cadmium contamination.

Only fertilisers and soil additives that comply with the legal limits for cadmium and have the lowest available impurity levels should be used. For example, special low-cadmium superphosphates are now available and should be used where phosphorus application rates are high or where higher-risk crops are grown.

Microbiological contamination

Microbiological contamination of fresh produce can be caused by the use of organic animal products as a fertiliser. Food poisoning microbes present in the guts of animals may transfer into the manure, and then on to fresh produce, thus causing a food safety hazard to humans.

Contamination can occur through *direct* contact of the organic product with the edible part of the crop (soil or foliar application) or *indirectly* through contact with contaminated soil or water. Fast growing short-term crops such as leafy vegetables should be carefully assessed before using organic animal products as a fertiliser.

There are a number of practices that can be adopted to minimise the risk of microbiological contamination of produce from the use of organic animal products.

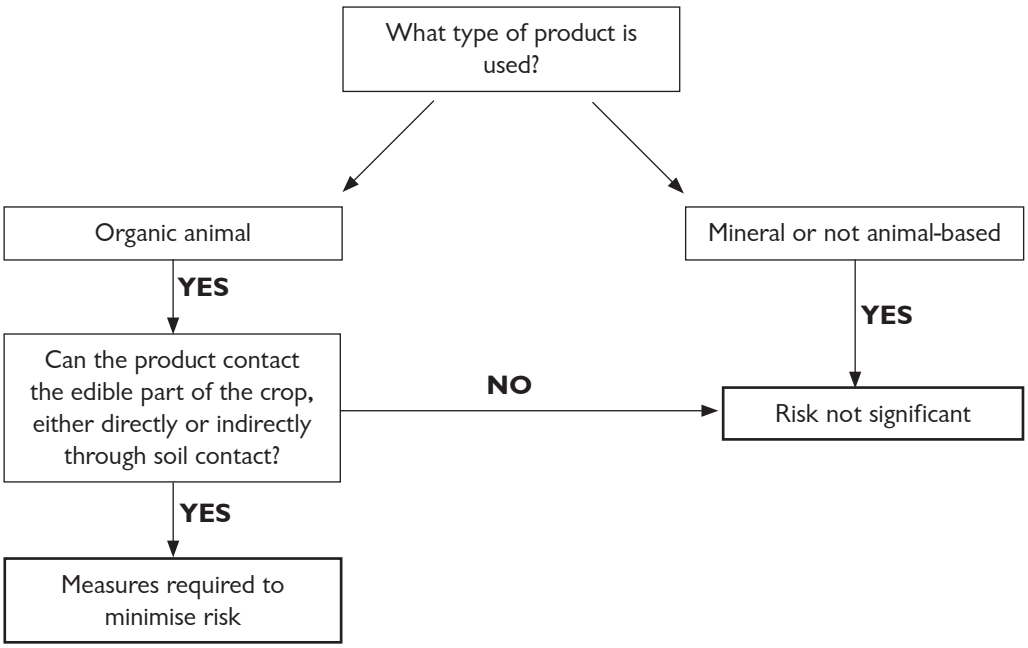
- Use an application method or growing practice that minimises the chance of the organic product coming into direct contact with the edible part. Examples include skirting tree crops, and growing crops on plastic.
- Incorporate the organic product into the soil to minimise contamination on to adjacent crops from wind drift or rainfall runoff.
- Maximise the period between when the organic product is applied and when the crop is harvested.
- Do not apply untreated animal manure within 60 days of harvest when there is a significant risk of direct or indirect contact with the edible part of the crop.
- Compost or age the animal manure to reduce microbe levels. Composting is more effective than aging. Longer treatment periods are required for aging (usually at least six months) than composting (about six weeks). It should be noted that vermicomposts (those produced from the activities of worms) have different microbiological profile than those of 'traditional' composts and therefore require a different management strategy.
- For proprietary organic products, use products that have been treated in their production to minimise microbe levels. Ask the supplier (manufacturer) for a specification to certify that the product has been treated. An example is pelletised manure.
- For side-dressing, only used properly-composted manure or treated proprietary organic products that contain less than 100 *E. coli* per gram. Ask the supplier for certification that this critical limit is not exceeded. Avoid applying composted manure or organic products over the top of produce. Do not apply a side dressing of treated organic product within two weeks of harvest.
- If stockpiling animal manures on-farm, locate the pile to avoid contamination from wind drift on to adjacent crops and harvested produce, and rainfall runoff into water sources.

- Minimise the potential risk of faecal contamination from the presence of livestock, or feral birds and animals. Do not allow grazing animals into growing crops during the last 60 days before harvesting produce.

Biosolids are produced during the biological treatment of sewage in Australia. In the future, consumer perceptions may result in customers specifying that biosolids are not to be used, particularly for class 1 fresh produce that can be eaten uncooked (see Appendix 1).

The use of biosolids presents risks that have not yet been properly researched. If biosolids are used, guidelines recommended by the Environmental Protection Agency (EPA) or other relevant authority must be followed. When purchasing biosolids ensure the supplier is approved by the EPA (or other relevant authority) and obtain certification of conformance with the requirements. When exporting fresh produce check the appropriate importing country standards.

Decision guide for assessing the risk of microbiological contamination from fertilisers and soil additives



5.4 Contamination from Water

Water is used during growing for irrigation and spraying, and after harvest for washing, unloading of field containers (water dumps), chemical treatment, hydro-cooling and top icing. In some hydroponic systems, water is constantly in contact with the roots of produce. In assessing the risk of contaminating produce from using water, factors that need to be considered are the source of the water, when and how the water is used and the type of produce. Taste, odour and colour may be the first indication of a potential health hazard, but should not be relied upon to guarantee the safety of water.

Source of water

Water is commonly sourced from creeks and rivers, dams, bores and water storage tanks, and may be contaminated by microbes or chemicals. Every effort should be made to minimise the risk of contamination at the source.

- Water from creeks and rivers may be contaminated with microbes if it flows near intensive livestock areas such as feedlots, dairies, and piggeries, and near areas of high human population. Chemical contamination may occur near industrial or agriculture areas that may release chemicals into the water sources.
- Water from dams may be contaminated by microbes from surface run-off and entry of livestock or bird life, or by chemicals if the chemical storage, or spray rig washing and filling area is close to the dam or waterway.
- Water from bores may be contaminated by microbes from seepage from septic systems or from heavily grazed catchment areas.
- Water storage tanks (commonly use for rainfall storage) may be contaminated by microbes from birds, rodents or other animal faeces on the roof and in the gutters of the roof where water is collected, and from dead birds, rodents and other animals in the gutters or tank.

Reclaimed Water
Reclaimed water is defined in Australia as water derived from sewage systems and industrial processes. In Australia there are up to four levels of treatment for reclaimed water, resulting in at least four classes of water (A, B, C and D, which vary from state to state). Class A reclaimed water has usually had the highest level of treatment and in terms of food safety is considered safe to use for the irrigation of all fresh produce. Because of the high treatment level and quality of Class A water, no withholding periods are required prior to harvest and there are no restrictions on the irrigation method.

Lower classes of water may be used for irrigation of fresh produce. However, there will be restrictions on the method of irrigation for most crops (e.g. reclaimed water should not come in contact with the harvestable portion of the crop).

If reclaimed water is used, guidelines recommended by your state Environmental Protection Agency (EPA) or other relevant state authorities must be followed. Purchase reclaimed water from a supplier approved by the EPA (or other relevant authority) and obtain certification of conformance with the requirements.

Use of water

The risk of microbiological contamination is higher if the water is applied to the edible parts of produce immediately before harvest or during packing. This may include overhead irrigation applied just before harvest, wash water, water in post-harvest chemical dips/sprays, water in

unloading tanks and troughs, water in hydro-coolers and water used for top icing of packages.

The risk is greater for water that is recycled and not adequately treated or maintained, particularly for washing produce. Irrigation water that does not contact produce, such as trickle irrigation, is a low risk. The quality of the water used for washing hands and cleaning surfaces or equipment that come into direct contact with produce needs to be considered as a potential risk.

Type of produce

The way produce is consumed and what part of the produce is edible affects the subsequent food safety risk of microbiological contamination. If produce is eaten without any preparation or a kill step (e.g. cooking), the risk can be higher compared to produce that is peeled or cooked before eating.

Testing water

It is impractical to test water for every possible microbiological pathogen. An easier approach to assess the risk of microbiological contamination is to test for the presence of a group of bacteria called faecal coliforms. They are also known as thermotolerant coliforms because they can tolerate high temperatures (up to 45°C). Some of these thermotolerant coliforms, such as strains of the bacteria *E. coli*, have caused outbreaks of food-borne illness.

What to Test for
Testing water for thermotolerant coliforms provides an indication of faecal contamination of the water, which may lead to microbiological contamination of the produce. The critical limits for levels of thermotolerant coliforms depend on how the water is used, the type of produce and whether the organisms will survive on the produce. In addition, the extent of the contamination of the water source, and hence the likely contamination of the produce, will determine the program of produce testing needed to verify effective control.

To assess whether recent faecal contamination is occurring, testing produce for the presence of the indicator organism *E. coli* is preferred to testing for thermotolerant coliforms. Some of the thermotolerant coliforms are produce spoilage organisms and their presence poses no risk to human health.

The decision guide flow charts on pages 24 and 25 provide guidance on the level of thermotolerant coliforms in water and *E. coli* on produce. In addition, the following provides a guideline for thermotolerant coliform loads for various water uses:

- Dam water for irrigation: if thermotolerant coliforms in water exceed 1,000 cfu/100 ml
- Water dump for unloading field containers: if thermotolerant coliforms in water exceed 100 cfu/100 ml
- Handwash/washing: if thermotolerant coliforms in water exceed 10 cfu/100 ml

Section 6 has further information on testing.

Treating water

Where there is a significant risk of contaminating produce from the water used, treatment of the water with sanitisers may be used. Sanitisers used on-farm for fresh produce need to be approved by the Australian Pesticides and Veterinary Medicines Authority (APVMA, website www.apvma.gov.au or phone 02 6272 5852).

There are a number of chemical sanitisers and non-chemical sanitising methods that can be used to treat water, and technical advice should be sought to ensure that the best option is used for the type of microorganism to be targeted. The common options include:

- Chlorine
- Chlorine dioxide
- Chloro-bromine compounds
- Hydrogen peroxide
- Peracetic acid
- Peroxy compounds (combinations of hydrogen peroxide and peracetic acid)
- Ozone
- Ultraviolet light

Many factors determine how well a sanitiser reduces microbiological loads. These include:

- the type of produce;
- the type of microorganisms present;
- the numbers of microorganisms on the produce and in the water;
- chemical conditions of the water such as pH;
- physical conditions of the water such as its temperature and the amount of organic material present;
- the concentration of the sanitiser; and
- the contact time between the produce and the sanitiser.

It is important to carefully review the best water treatment for the operation, based on sound technical advice, and following the manufacturer's guidelines. Treatment of water with a sanitiser should be monitored to ensure that it achieves the desired level of microorganism control. A record should be kept of the results to track any trends that may occur during the season.

Decision guides for assessing the risk of microbiological contamination from water

(a) Water used for crop spraying

Water used for pre-harvest spraying, to apply chemicals and foliar fertilisers, generally poses a low risk of microbiological contamination, as the sprays are usually not applied immediately before harvest. Where sprays are applied within two days of harvest to the edible parts of crops that are eaten uncooked, the same decision guide as for 'water used for irrigation' should be used.

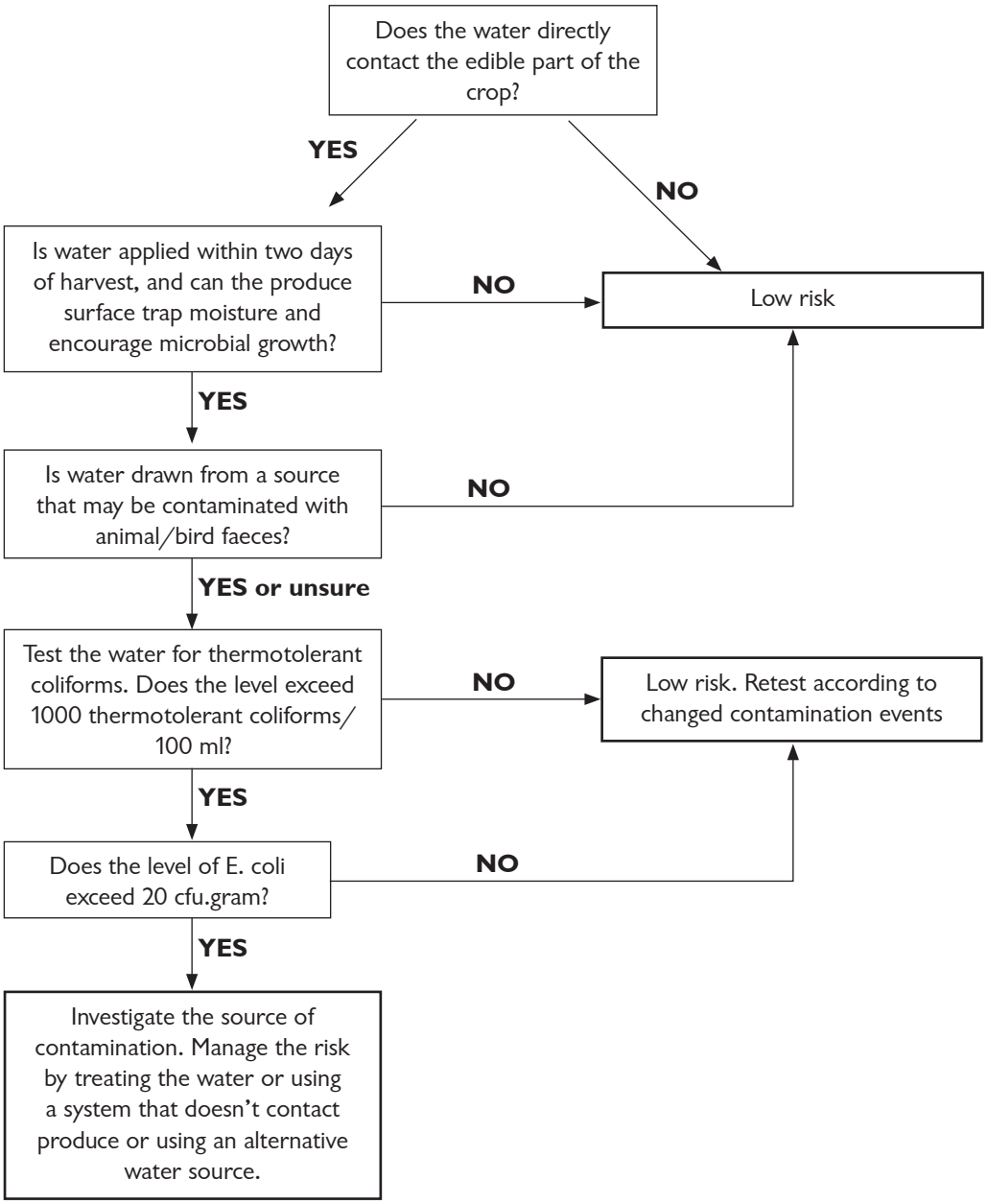
(b) Water used for hydroponics

Water used in hydroponics may pose a significant risk of microbiological contamination of produce for systems where the nutrient solution contacts the edible part of the crop. For these systems, the same decision guide as for 'water used during or after harvest' should be used.

An example is the nutrient film technique used for hydroponic lettuce. The nutrient solution is recirculated and in constant contact with the roots, and may splash on to the lettuce head during harvesting and packing. The nutrient solution should be sanitised and monitored to maintain the water quality during the solution life cycle.

Run-to-waste systems generally pose a lower risk as they are mostly used for crops where the nutrient solution does not come in contact with the edible part of the crop.

(c) Water used for irrigation



(d) Water used during or after harvest

Water may be used during or after harvest for some produce during the following process steps:

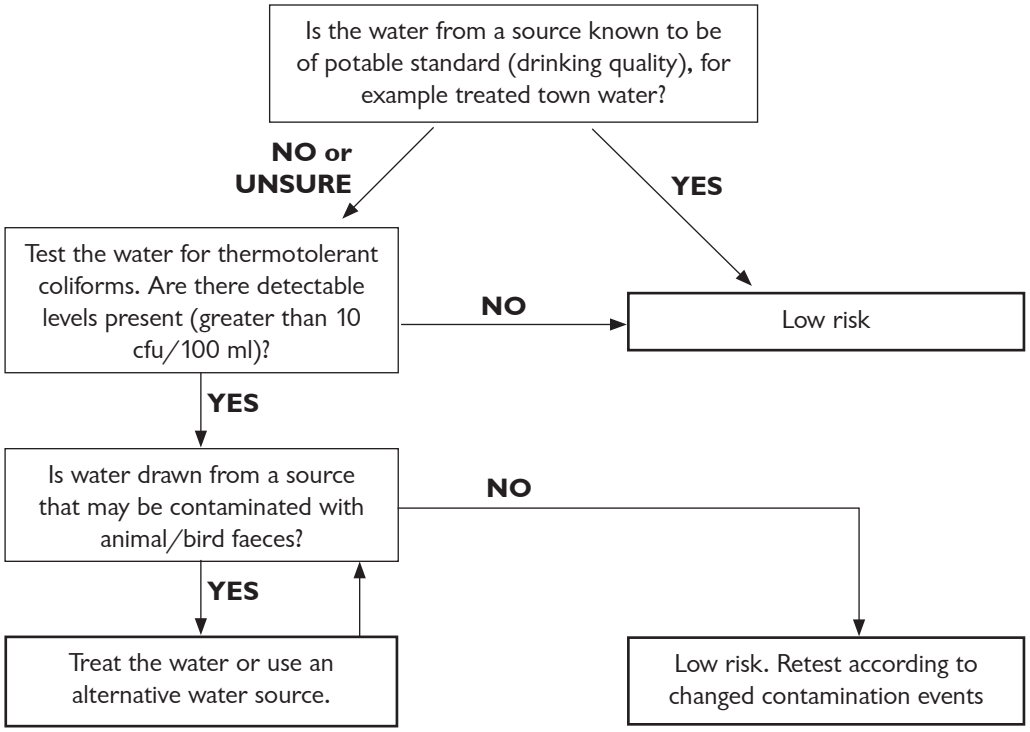
- Unloading of field containers and bins (water dumps and troughs)
- Washing produce
- Hand-washing
- Chemical treatment with fungicides and insecticides
- Hydro-cooling
- Top-icing

Water applied during or after harvest to produce with an inedible skin generally poses a low risk of contamination of the edible portion. However, cross contamination of hands and cutting knives can

occur in food service and home kitchens if there is gross contamination of the skin. Where gross contamination may occur (for example, water from a dam beside an animal feedlot), test a sample of the produce using *E. coli* as the indicator organism (see section 6.2). If the level of *E. coli* exceeds 20 cfu/gram, either treat the water or use an alternative water source.

For all other produce, use the following decision guide to assess the risk of microbiological contamination of the produce. The water should be of potable standard (drinking quality) particularly for final wash/rinse steps.

At present, no class of reclaimed water is considered of a potable standard. This should be verified with your state EPA or relevant state authority.



(e) Water used for hand washing

Water used for hand washing should be potable. Use a treated water supply if it is available. If a treated water supply is unavailable, test the water for presence of thermotolerant coliforms. The level should not exceed 10 cfu/100 ml. If the water used for hand washing is prone to faecal contamination, workers directly handling produce should use hand sanitisers.

Class A reclaimed water and any lower classes are not generally considered of a potable standard. This should be verified with your state EPA or relevant state authority.

5.5 Contamination from people

People are an important part of fresh produce production. It is important to assess the risk of microbiological contamination from staff handling produce. People are generally a source of microbiological contamination, including bacteria, such as *E. coli*, and viruses such as Hepatitis A. Adequate facilities must be provided for staff, such as toilets and hand washing facilities, to prevent microbiological contamination of produce.

In assessing the risk of contamination, review the competence, experience and capabilities of staff to ensure that they pose no threat to food safety while handling produce. Training should be conducted in personal hygiene standards (e.g. hand washing, no smoking, no communicable diseases) with regular re-enforcement on-site (e.g. signs) and records kept to demonstrate that staff members understand their obligations.

Supervisors should be trained to identify employees with gastro-intestinal complaints or open wounds so that they can be given tasks that do not involve contact with fresh produce. General symptoms that may indicate a potential cause of contamination include diarrhoea, vomiting, dizziness, abdominal cramps, exposed wounds or jaundiced (yellow) skin colour.

6 – Testing information (including soil testing)

The requirements for chemical and microbiological testing of fresh produce is an area of significant debate and uncertainty. The following guidelines are provided to help standardise the approach to these tests.

6.1 Chemical testing

The main purpose for chemical testing of fresh produce is to verify that chemicals are being applied according to label or permit instructions.

Withholding Period (WHP)
The withholding period is the time elapsed between the last treatment with a chemical and the harvest of a crop. Withholding periods are specified on product labels to ensure that any chemical residues on produce are below the maximum residue limit (MRL).

Maximum Residue Limits
The maximum residue limit (MRL) for registered crop protection chemicals is established by the Australian Pesticides and Veterinary Medicines Authority (APVMA, website www.apvma.gov.au or phone 02 6272 5158). The MRL is the maximum concentration (mg/kg) of a residue that is legally permitted after produce is sprayed on-farm. Carefully check state requirements for on-farm use of chemicals as there may be some differences between control of use regulations for control of use.

The MRLs for harvested fresh produce are incorporated into the Food Standards Code, Section 1.4.2 - and are published and managed by FSANZ (website www.fsanz.gov.au or phone 02 6271 2222). For export of produce, a check of the appropriate importing country MRLs should be undertaken.

Produce test results are checked against the MRL of the chemical for the specific crop. Chemical residue testing may also be needed to assess the risk of contamination from persistent chemicals and heavy metals in the soil (see sections 5.1 and 5.2), and the same testing principles apply.

Permits
In certain circumstances, 'off-label' permits may be obtained for the legal use of chemicals in ways different to the registered uses printed on the label (e.g. for minor use crops, exotic disease outbreaks, or research trials). Permits may only be granted by the APVMA, and existing permits can be viewed on-line at: www.apvma.gov.au/permits/permits.shtml

What to test for

Testing produce to verify that chemicals are applied correctly should be risk based, with sound scientific reference. There is no need to test the produce for every chemical that may be applied or every type of produce grown on the farm. The chemical application program is being verified, not the application of every chemical. However, standard analysis screens may include a broad range of MRLs at a cost-effective price, and these are now commonly used for verification testing. Alternatively a pesticide (insecticide, fungicide, herbicide) that poses the highest risk for the MRL being exceeded can be selected for testing.

The categories of chemicals that are the highest risk for the MRL being exceeded are:

- chemicals applied regularly close to harvest;
- chemicals with a long withholding period or where there is a risk that produce may be

harvested within the withholding period;
- chemicals rated Schedule 6 and higher;
- chemicals applied after harvest; and
- chemicals from possible spray drift.

The results of residue testing by industry or government testing programs can help in assessing the risk of chemicals exceeding the MRL. The Australian National Residue Survey program data are available for limited fresh produce lines (e.g. onions, pome fruit, macadamia nuts) on the DAFF website (www.daff.gov.au/nrs) or phone 02 6272 3446.

How often to test

Chemical residue testing should be done once a year to verify the chemical application program. If more than one type of produce is grown, only one type needs to be tested each year. A rotation system should be used with a different type of produce tested each year. It may be possible to reduce the frequency of tests once a successful track record of correct application is established, provided the chemical application program doesn't change.

Where to sample

The produce must be sampled at or just prior to the point at which it is first available to the customer. This can be just after harvest or packing, or just before or on delivery to the customer. Where the produce is stored for an extended period before delivery, such as apples, collect the sample before storage. If the post-harvest application of chemicals for long-term storage is being verified, then produce should be sampled after storage.

The sample must be unbiased and representative of the produce supplied. The grower or customer such as a wholesaler, processor or packer may select the sample and organise residue testing.

How to sample

The Codex Alimentarius Commission provides guidelines on the quantity of sample required for testing purposes (refer to www.codexalimentarius.net or phone 02 6272 5692).
A summary of these guidelines is provided below.

Produce type	Examples	Minimum quantity
Small or light products, unit weight up to about 25 grams	berries, peas, olives, parsley	1 kilogram
Medium-sized products, unit weight usually between 25 and 250 grams	apples, oranges, carrots, potatoes	1 kilogram (at least 10 units)
Large-sized products, unit weight over 250 grams	cabbage, melons, cucumbers	2 kilograms (at least 5 units)

Before sending a sample for testing, check that the laboratory can test for the selected chemical, the sample size required and how best to transport the sample. When collecting and transporting samples, avoid cross contamination from other causes and deterioration of the produce. Guidelines to follow are:

- use disposable gloves (or thoroughly washed hands) to collect the sample;
- place the sample in a clean plastic bag and/or box to protect it during transport;
- clearly label the sample with your name, address, telephone number and other details (don't forget to record the date of sample collection, and from where it was collected);
- clearly indicate what chemical you want the laboratory to test for;

- store the sample in a cool (but not frozen) state until ready to transport; and
- use overnight freight to ensure the sample gets to the laboratory promptly.

Choice of laboratory

Choose a laboratory that is technically competent in analysing pesticide residues in fresh produce. The laboratory should have NATA (National Association of Testing Authorities) accreditation for analysing pesticide residues and heavy metals in fresh produce. Information about the accreditation status of laboratories can be accessed on the NATA website (www.nata.asn.au/directory.htm – follow the directions to Chemical Testing and then Pesticide Residues). The laboratory may also provide a copy of the tests and matrices for which they are accredited upon request. FreshTest Australia Ltd (02 9764 3244) offers a national produce testing service, using multi-residue screening through NATA-certified laboratories.

The Australasian Soil and Plant Analysis Council (ASPAC) runs an analytical quality assurance program for plant chemical analysis and offers certification of laboratories. As part of the National Cadmium Minimisation Strategy, ASPAC has extended this service from plant nutrient determination to cover cadmium residues in produce.

6.2 Microbiological testing

Unlike chemical residue testing where MRLs are specified by government regulations, there are currently no regulations that specify critical limits for microbe levels on produce sold for fresh consumption (without any further processing). This reflects the difficulty of defining a range of microbiological limits that would be appropriate for the whole population. The situation may change in the future as more research is conducted and data becomes available to establish critical limits.

It is important to understand the limitations of microbiological testing and what the results mean in terms of food safety. Preventive measures are clearly superior to testing in assuring the safety of harvested produce.

It is not recommended to use microbiological testing of a limited sample of produce as the basis for accepting or rejecting a consignment or a supplier. The presence of microbes on produce does not mean the produce is unsafe to eat and conversely a negative result does not verify that the food is safe to eat.

To have some confidence in the test result, a large number of samples need to be taken, particularly if the level of contamination is low or localised within a batch. The cost would be high and therefore this level of testing is not practical. Using a preventative approach with good agriculture practices is more effective than relying on microbiological testing of produce.

Microbiological testing of produce can, however, be useful as a verification tool, to check for gross contamination of produce and to test the effectiveness of management practices used to prevent, reduce or eliminate the contamination. For example, produce could be tested after harvest to determine whether microbes present in the irrigation water survive on the produce and are present at the time of harvest.

What to test for

To assess whether gross faecal contamination is occurring, test a sample of the produce for the presence of the indicator organism *E. coli*. If the level exceeds 20 cfu/gram, the process steps should be investigated for causes of recent faecal contamination and appropriate control measures implemented.

Customer or regulatory requirements may require additional testing for other microorganisms, particularly if produce has no subsequent process that will destroy them, or if it is destined for immune sensitive consumers in hospitals or retirement homes.

a) Listeria

Listeria organisms are commonly found in the environment, and carriers include many species of animals. The widely recognised food-borne pathogen, *Listeria monocytogenes* can be transmitted to humans on produce through contamination from water, soil, manure or compost. While it has been detected on freshcut packaged vegetables where there is no further processing step (e.g. cooking), the overall risk of contracting listeriosis is quite low. If the level of *Listeria monocytogenes* exceeds 100 cfu/gram on fresh produce at consumption, the process steps should be investigated for causes of contamination and appropriate control measures implemented.

b) Salmonella

Species of Salmonella bacteria are found in the intestinal tracts of a wide variety of birds and animals, and it is a significant public health concern. While the incidence of Salmonellae in fresh produce is usually low, contamination is possible from the environment. It can be shed in faeces to contaminate soil, water, or pasture and will survive in the soil for many months. It may also be found in organic fertilisers and composted biosolids (refer to section 5.3). Most Salmonellae do not grow at temperatures below 7°C, and the optimum temperature for growth is 35-37 °C. If the presence of Salmonellae is detected in a 25 g sample of fresh produce, the process steps should be investigated for causes of contamination and appropriate control measures implemented.

How often to test

If water testing is required to determine the risk of contamination, it should be done at times when the likelihood of contamination is highest and at a frequency that allows management of the potential risk. For example, test water when the condition of the source changes or to check whether a water treatment process is effective.

As a general guide, test produce where there is a high risk that a particular practice may lead to gross contamination of produce. Test once each growing season for the first 12 months and then at least once every 12 months. If gross contamination is detected, implement appropriate control measures and re-test to verify the effectiveness of corrective action taken.

Where to sample

Water should be sampled at the point where it contacts produce. How often the water needs to be tested will depend on the risk factors described in Section 5.4 and the variability of the water source. For example, water sourced from dams and creeks is more likely to be influenced by run-off into catchments following rain, than water from deep underground bores.

To check for gross contamination, sample the produce on the farm when it is ready for dispatch to the customer. To check the effectiveness of a particular practice, sample the produce immediately after the practice. For example, to check the effectiveness of washing, sample the produce immediately after the wash treatment.

[1] Australian Soil Fertility Manual, Fertilizer Industry Federation of Australia (Pub) CSIRO, 1999

How to sample

Before sampling, contact the testing laboratory for instructions on sampling, handling and transport of samples. As a guide, collect a sample by selecting three units at random from a batch. For example, collect three lettuces or cabbages. For small produce (e.g. snow peas), select three units each containing 500 grams. Test each unit for *E. coli*.

When collecting and transporting samples, avoid cross contamination from other causes and deterioration of the produce. Guidelines to follow are:

- use disposable gloves to collect the sample;
- place the sample in a clean plastic bag and then in a package to protect it during transport;
- clearly label the sample with your name, address, telephone number and other details (record the date of sample collection, and from where it was collected);
- store the sample in a cool (but not frozen) state until ready to transport;
- transport samples under refrigeration conditions such as in a polystyrene container with ice; and
- use overnight freight to ensure the sample gets to the laboratory promptly.

Choice of laboratory

Choose a laboratory that is technically competent in microbiological testing of fresh produce. The laboratory should have third party accreditation with a recognised body (e.g. NATA accreditation). Request the laboratories to provide evidence of their accreditation or visit the NATA website (Refer to www.nata.asn.au/directory.htm – then follow the directions to Biological Testing) to access details of laboratory accreditation. Some local councils may also provide testing services. Before sending water samples, contact the laboratories for instructions on how to collect and transport the water samples.

6.3 Soil testing

Soil testing refers to the full range of chemical, physical and microbiological analysis of soil samples. It is becoming increasingly important as a diagnostic tool for assessing the risk of produce contamination.

How to sample

The greatest source of error in soil testing tends to be in the collection of samples. If a soil sample of, say, 500 g is taken, it may represent the production zone of about 1,500 tonnes/ha to a depth of 10 cm. In the laboratory, only about a teaspoon of that soil sample is used in the analytical procedure.

The procedure used to collect a sample should reflect the reason for collecting it, and be as representative as possible of the production area[1]. The soil sample should be a composite sample, made up of between 25-30 individual cores, taken from a circular area of about 20-30 m in diameter.

[1] Australian Soil Fertility Manual, Fertilizer Industry Federation of Australia (Pub) CSIRO, 1999

Appendix 1 – Microbiological risk categories – fresh produce

The following table classifies fresh produce crops into three broad microbiological risk categories. Classes 1 and 3 are split into two sub-categories with A being higher risk than B. The crops have been classified according to their growing characteristics and final use by consumers.

The categories are generalisations and should not be taken as absolute assessments of microbiological risk. The risk of microbiological contamination must be assessed for each crop based the process steps and inputs used.

Research to date has not developed microbiological critical limits specific to the risk category of produce.

Class 1	Class 2	Class 3
1A. Can be eaten uncooked, grown in or close to ground or have a large uneven surface area	**Generally eaten cooked**	**3A. Crops grown over 1 metre above ground, edible skin**
Cabbage	Artichoke (Globe/Jerusalem)	
Carrot	Asparagus	Apple
Celery	Beetroot	Apricot
Chinese white cabbage (Chinese chard, pak choy, buk choy, tat tsoi)	Broccoflower	Cherry
Fresh herbs (parsley, etc)	Brussel sprout	Grape
Leek	Chinese broccoli (Gai lum)	Nashi
Lettuce (and lettuce types)	Chinese cabbage (wong bok)	Nectarine
Mushroom	Chinese waterchestnut	Olives
Onion (salad)	Chinese spinach	Peach
Radish	Eggplant	Pear
Shallot (spring onion)	Ginger	Plum
Spinach	Parsnip	
Strawberry	Pea	**3B. Crops grown over 1 metre above ground, skin not normally eaten**
Witlof	Peanut	Avocado
	Potato	Banana
1B. Can be eaten uncooked, grown off the ground or protected by skin	Pumpkin	Custard apple
Bean	Rhubarb	Grapefruit
Berryfruit (blackcurrant, blueberry, raspberry etc)	Silverbeet	Kiwifruit
Broccoli	Squash (button etc)	Papaw
Capsicum	Swede	Passionfruit
Cauliflower	Sweet corn	Persimmon
Chilli	Sweet potato	Pineapple
Cucumber	Taro	Lemon
Garlic	Turnip	Lime
Melons (rockmelon, water melon, honeydew)	Zucchini	Lychee
Onion (cured)		Longan
Snow pea		Mandarin
Tomato		Mango
		Nuts (almond, cashew, chestnut, hazelnut, pecan, pistachio, walnut)
		Orange
		Rambutan

Source: Based on *Safe Vegetable Production: A Microbial Food Safety Guide for the Australian Vegetable Industry*, Institute for Horticultural Development, Victorian Department of Natural Resources and Environment, 2002.

Appendix 2 – Review checklist – good agricultural practices

The review checklist identifies the good agricultural practices that should be addressed in on-farm food safety programs for fresh produce. The checklist is divided into sections according to the potential causes of contamination. The practices have been identified from industry food safety programs based on the Hazard Analysis and Critical Control Points (HACCP) method. The checklist can be used to supplement existing audit checklists used by certification bodies or for internal audits carried out by individual businesses. As with any generic checklist some items may not be considered relevant and can be excluded, and others may be included.

Chemicals	In place	Needs attention	Not relevant	Actions required
1 The person responsible for supervising the use of farm chemicals has a current certificate from an APVMA-approved farm chemical use course.	❑	❑	❑	
2 A register of staff authorised by the business owner or manager to use farm chemicals is displayed in the chemical storage area.	❑	❑	❑	
3 All farm chemicals are purchased from Agsafe-accredited suppliers.	❑	❑	❑	
4 All chemicals are safely stored in a structurally sound, secure area, according to label instructions. The store is constructed and located to minimise the risk of contamination of sites, produce and packing materials.	❑	❑	❑	
5 Old deregistered chemicals have been disposed of in legal off-farm areas or isolated from other chemicals in separate locked storage.	❑	❑	❑	
6 A farm chemical inventory or equivalent system is maintained to keep a record of the chemical name, date received, place of purchase, quantity purchased, batch number and expiry date/date of manufacture.	❑	❑	❑	
7 A stocktake of the chemical store is completed every 12 months, and a record kept of any chemicals disposed of and how, the date of the stocktake and name of the person.	❑	❑	❑	
8 Chemicals used are approved for the targeted crops and applied according to the label or permit.	❑	❑	❑	
9 Chemical application equipment is calibrated at least yearly, and the date and person responsible recorded.	❑	❑	❑	
10 The application of chemicals during growing is recorded, detailing at least the date, chemical used, dilution or application rate, application method, area treated, withholding period/ date safe to harvest, and name of operator.	❑	❑	❑	

Chemicals (cont)	In place	Needs attention	Not relevant	Actions required
11 The application of chemicals after harvest is recorded, detailing at least the date, chemical used, dilution or application rate, application method, and name of person responsible.	❑	❑	❑	
12 A chemical residue test of product has been done in the past 12 months to verify that chemicals are applied correctly (see section 6).	❑	❑	❑	
Fertilisers and soil additives				
13 The potential risk of chemical and microbiological contamination of produce from the use of fertilisers and soil additives has been assessed (see section 5.3) and a record has been kept of the assessment.	❑	❑	❑	
14 Where there is a significant risk of heavy metal contamination, fertilisers and soil additives are selected to minimise the risk and measures are taken to minimise uptake.	❑	❑	❑	
15 Where there is a significant risk of microbiological contamination from organic animal products, measures are taken to minimise the risk.	❑	❑	❑	
16 Untreated organic materials are not applied in situations where there is a significant risk of contaminating produce	❑	❑	❑	
17 Where organic animal products require treatment on the farm before use, the date and treatment method is recorded.	❑	❑	❑	
18 Where organic animal products require treatment before purchase, documentation is obtained from the supplier to demonstrate that the product presents a low risk of contaminating produce.	❑	❑	❑	
19 The application of fertilisers and soil additives is recorded, detailing name of product, date, area treated, rate, and person applying.	❑	❑	❑	
20 Fertilisers and soil additives are stored, applied and disposed of in a manner that does not pose a risk of contaminating produce.	❑	❑	❑	
21 The potential risk of chemical and microbiological contamination of produce from the use of water has been assessed (see section 5.4) and a record has been kept of the assessment.	❑	❑	❑	
22 If the risk of chemical or microbiological contamination is significant, either a safe alternative water source is used or the water is treated, the treatment monitored, and a record kept of the monitoring results.	❑	❑	❑	
23 If reclaimed water is used on the property, onsite management plans have been completed and comply with the requirements for use of reclaimed water. (e.g. appropriate signage on reclaimed water taps and entrances to the property and plumbing used for reticulating reclaimed water painted lilac).	❑	❑	❑	

Water use	**In place**	**Needs attention**	**Not relevant**	**Actions required**
24 Where water testing is required to assess the risk of produce contamination, tests are conducted annually or at a frequency appropriate to the conditions impacting on the water supply and the horticultural activity. A record of the test results is kept.	❑	❑	❑	
Site and premises				
25 The potential risk of chemical contamination from persistent chemicals and heavy metals in the soil at growing sites has been assessed (see sections 5.1, 5.2) and a record kept.	❑	❑	❑	
26 Where a significant risk of contamination from persistent chemicals and heavy metals has been identified, the site has been quarantined or is managed to minimise the risk.	❑	❑	❑	
27 The premises used for packing, handling and storage are constructed and maintained to minimise the risk of contaminating produce.	❑	❑	❑	
28 Grease, oil, fuel, and farm machinery are segregated by distance or a physical barrier from handling, packing and storage areas to prevent contamination of produce.	❑	❑	❑	
29 Where workshop equipment is located in the same premise, the equipment is screened with a physical barrier from the packing, handling and storage area or it is not operated during packing, handling, storage.	❑	❑	❑	
30 Septic, waste disposal and drainage systems are designed and constructed to minimise the risk of contaminating the water supply.	❑	❑	❑	
31 Lights above areas where produce and packaging containers and materials are exposed are either shatter proof or protected with shatter proof covers or in the event of a light breaking, there is a plan to reject exposed produce and clean equipment, packaging containers and materials and surrounding areas.	❑	❑	❑	
32 Structures are constructed and maintained to minimise the risk of contaminating produce.	❑	❑	❑	

Equipment, containers and materials	In place	Needs attention	Not relevant	Actions required
33 Equipment, containers and materials are made of substances that are non-toxic and constructed to enable adequate cleaning and maintenance.	❑	❑	❑	
34 Regular equipment maintenance and cleaning is carried out to minimise contamination of produce.	❑	❑	❑	
35 Packaging containers and materials are checked for soundness, cleanliness and vermin infestation before use and discarded if they cannot be appropriately cleaned.	❑	❑	❑	
36 Containers used for storage of waste, chemicals and other dangerous substances are clearly identified and not used for holding of produce.	❑	❑	❑	
Cleaning and vermin control				
37 A written plan is followed for the cleaning of equipment, containers and materials that come in contact with produce, and areas where produce is handled, packed and stored.	❑	❑	❑	
38 A written plan is followed for vermin control to minimise the presence of vermin in and around handling, packing and storage areas.	❑	❑	❑	
39 Measures are taken to discourage the roosting of birds above packing, handling and storage areas.	❑	❑	❑	
40 Domestic animals are excluded from areas where produce is packed, handled and stored.	❑	❑	❑	
41 Appropriate cleaning chemicals are used to minimise the risk of chemical and microbiological contamination of produce.	❑	❑	❑	
42 Baits and traps used for vermin control are located and maintained to minimise the risk of contaminating produce and packaging containers and materials, and the location is recorded.	❑	❑	❑	
Personal hygiene				
43 Toilets and hand washing facilities are readily accessible to staff.	❑	❑	❑	
44 Verbal instructions on personal hygiene practices are provided to staff, including a statement about communicable diseases (e.g. *Hepatitis A*), and a record is kept that the instructions have been provided.	❑	❑	❑	
45 Personal hygiene policies are reinforced with written instructions or prominent signs.	❑	❑	❑	

Storage, ripening and transport	**In place**	**Needs attention**	**Not relevant**	**Actions required**
46 Pallets are checked before use for possible contamination from soil, chemical spills, foreign objects and pests. If unsuitable they are rejected, cleaned or covered with protective material.	❑	❑	❑	
47 Measures are taken to prevent condensate and defrost water from cooling systems dripping on to exposed produce.	❑	❑	❑	
48 Transport vehicles used on site are checked before use for cleanliness, physical contamination and vermin infestation, and cleaned if there is a significant risk of contaminating produce.	❑	❑	❑	
49 Produce is stored, ripened and transported separate to goods that are a potential cause of chemical, microbiological and physical contamination.	❑	❑	❑	
50 Where storage, ripening or transport services are provided off site, evidence is obtained that measures are taken to control potential food safety hazards.	❑	❑	❑	
Product identification and traceability				
51 The locations of separate growing areas and contaminated sites are identified on a farm map.	❑	❑	❑	
For harvested product sent to another business for packing: 52 Where separate growing areas are treated differently, each batch of harvested produce is clearly marked to identify the growing area.	❑	❑	❑	
53 A record has been kept of harvest date and growing area, and destination if produce is sent to another business for packing.	❑	❑	❑	
For all packed product: 54 Packed produce ready for delivery to customers is clearly marked with the business name, packing date or batch identification code and other trade description requirements.	❑	❑	❑	
55 A record has been kept of packing date, batch identification code if used, source of produce (growing area identification) and destination.	❑	❑	❑	
56 Customers are notified immediately of any sold produce that is identified as being contaminated or potentially contaminated and a record is kept.	❑	❑	❑	

Notes

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For further information please contact:
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