Interpretive guide for

ASEAN GAP

Good agricultural practices for production of fresh fruit and vegetables in ASEAN countries

Food Safety Module

January 2007

Australian Government
AusAID

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Cardno ACIL

RMIT International

Quality Assurance Systems for ASEAN Fruit and Vegetables Project
ASEAN-Australia Development Cooperation Program – Program Stream

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Contents

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References

Many guidelines for GAP from around the world were used as references to prepare this interpretive guide. The main source of information used was:

- Guidelines for On-farm Food Safety for Fresh Produce. 2004. Department of Agriculture, Fisheries and Forestry, Australia

Project funding

The development of ASEAN GAP is an activity within the project, Quality Assurance Systems for ASEAN Fruit and Vegetables (QASAFV). The QASAFV project is an initiative under the ASEAN Australia Development Cooperation Program (AADCP).

The AADCP is funded by Australia's overseas aid agency, AusAID, and Cardno ACIL Pty Ltd is AusAID's Australian managing contractor for the program.

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1. Introduction

1.1 Purpose and scope of guide

ASEAN GAP is a standard for good agricultural practices to control hazards during the production, harvesting and postharvest handling of fresh fruit and vegetables in the ASEAN member countries. ASEAN GAP is divided into four modules – 1. Food safety, 2. Environmental management, 3. Worker health, safety and welfare and 4. Produce quality.

ASEAN GAP has been developed to enhance the harmonisation of GAP programs amongst ASEAN member countries. It covers the production, harvesting and postharvest handling of fresh fruit and vegetables on farm and postharvest handling in locations where produce is packed for sale.

This interpretive guide was designed to assist producers, packers, supply chain businesses, trainers, government representatives and others to understand the practices required for implementing the Food Safety Module of ASEAN GAP. It provides guidance on "what has to be done" to implement the required practices. Separate interpretive guides are available for the other ASEAN GAP modules.

Products that present high risk to food safety, such as sprouts and minimally processed products, are not covered in the scope of ASEAN GAP. ASEAN GAP may be used for all types of productions systems but it is not a standard for certification of organic products or GMO free products.

1.2 Guide sections

The guide contains background information on types of food safety hazards and sources of contamination, guidance on implementing the GAP requirements, a self-assessment checklist to review compliance with the requirements, examples of documents and records, a glossary of terms and references and additional information.

Section 2. Hazards and sources of contamination

This section provides information about the potential food safety hazards and possible sources of contamination. There are three major types of food safety hazard – chemical, biological, and physical. Contamination of produce can occur directly through contact of produce with contaminants, or indirectly through produce coming in contact with contaminated surfaces or substances.

Section 3. GAP requirements

The good agricultural practices for controlling food safety hazards are grouped into 10 elements. Each element has background information to explain how contamination can occur. Specific information is then provided for each practice to explain what is required to implement the practice. In some cases, two or more practices are grouped together as the guidance information is the same for both practices.

Section 4. Self-assessment checklist

The self-assessment checklist enables the producer or packing manager or advisor to assess the level of compliance with the good agricultural practices contained in the food safety module. The relevance of the practices will depend on the location of the farm or packing business, type of produce, and the systems used for production, harvesting, handling, packing, storage and transport. The person assesses whether the practice is done correctly or if attention is needed or if the practice is not relevant. If attention is needed, the actions required are identified and recorded.

Section 5. Examples of documents and records

The section contains examples of documents and record forms that are required to implement various practices in the food safety module. The documents and record forms are examples only and other methods and formats can be used. ASEAN GAP specifies the information that has to be documented and the records to keep, but does not specify how to document information and keep records.

Appendix 1. Glossary of terms

This appendix contains definitions for the abbreviations and terms used in the guide.

Appendix 2. References and additional information

This appendix contains references and additional information on control of food safety hazards for fresh produce. It includes lists of training programs, GAP guidelines, publications, GAP systems and organisations.

2. Hazards and sources of contamination

A ***food safety hazard*** is any chemical, biological, or physical substance or property that can cause fresh fruit and vegetables to become an unacceptable health risk to consumers.

Controlling food safety hazards during production, harvesting and postharvest handling (trimming, grading, packing, transport etc) of fresh produce is important to protect consumer health and to gain access to markets in the ASEAN region and globally.

There are 3 categories of food safety hazards:

1 Chemical

2 Biological

3 Physical

Contamination of fresh fruits and vegetables can occur through direct contact of produce with the hazards or indirectly through the produce coming into contact with contaminated soil, water, people, equipment, materials, fertilisers and soil additives, and so.

2.1 Chemical hazards

Chemical contaminants in fresh fruit and vegetables may occur naturally or may be added during production, harvesting and postharvest handling of fresh produce. Types of chemical hazards include:

- agrochemical residues in produce exceeding maximum residue limits (MRL),
- non-agrochemical contaminants – for example, fuels, lubricants and sanitisers,
- heavy metals exceeding maximum levels (ML),
- naturally occurring plant toxins, and
- allergenic agents.

Figure 1. The use of pesticides that are not approved for the crop and the continued use of fertilizers with high levels of heavy metals are common sources of chemical hazards.

Common sources of chemical hazards are listed in the following table.

Chemical hazard	Sources of contamination
Agrochemical residues in produce exceeding maximum residue limits (MRL)	• Agrochemical residues in produce exceeding maximum residue limits (MRL) • Agrochemical not registered or approved for target crop (zero MRL) • Failure to follow label instructions resulting in incorrect mixing and the concentration being higher than the recommended dosage • Withholding period not observed • Spraying equipment faulty or not calibrated correctly or not cleaned properly after the last use or used for multi-purposes • Spray drift from adjacent plots • Chemical residue in soil from previous use • Chemical residue in harvesting containers • Improper dumping, accidental spillage or seepage of chemicals into soil or water source due to poor storage conditions
Non-agrochemical contaminants – for example, lubricants, fuels, cleaners, sanitisers, pest control chemicals, adhesives	• Inappropriate chemical used for cleaning or sanitation of equipment or used at wrong dosage • Inappropriate application of chemicals – for example, pest control chemical sprayed near produce or packaging materials • Chemical spill near produce or cross contamination of chemical during storage and transport with produce • Oil leaks, grease, paint on equipment in contact with produce • Use of harvesting containers to store chemicals • Soil contaminated with persistent chemicals from previous war activities
Heavy metal residues exceeding maximum levels	• High levels of heavy metals present in soil, either occurring naturally or from previous use or from leakage from industrial sites • Continued use of fertilizers with high levels of heavy metals • Development of soil conditions conducive to uptake of heavy metals by crops – for example, acidity, salinity, zinc
Natural plant toxins	• Unsuitable storage conditions - for example storage of potato in light • Planting toxic varieties - for example cassava
Allergenic agents	• Traces of a substance that causes a severe reaction in susceptible consumers – for example sulphur dioxide used to prevent rots on grapes, lychees and longans

2.2 Biological hazards

Microorganisms or microbes are organisms that can only be seen through a microscope. Microorganisms are found everywhere in the environment. Fruit and vegetables typically contain a diverse mixture of a large number of microorganisms.

Some of these microorganisms cause spoilage by producing undesirable quality characteristics such as flesh breakdown and bad odour and flavour. Other microorganisms are natural inhabitants and do not cause spoilage or affect the health of consumers.
Pathogenic microorganisms affect consumer health and cause illness either by the microorganism itself growing inside the human or by toxins produced by the microorganism.

Pathogenic microorganisms are mostly found on the outside of fresh fruit and vegetables but some can get inside the plant tissue. The common types of pathogenic microorganisms are:

- Bacteria
- Parasites
- Viruses

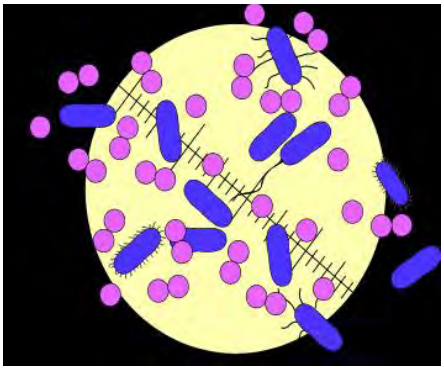


Figure 2. The types of microorganisms that cause illness are bacteria, parasites and viruses.

Bacteria

Bacteria are the most common cause of food-borne illness. The number of bacteria that must be present to cause human illness varies with the organism and the age and condition of the produce. In order to multiply, bacteria require adequate nutrients and appropriate environmental conditions such as high humidity and warm temperatures.

Bacteria can grow rapidly in a very short time. In 7 hours, one bacterial cell can generate over a million cells.

Common examples of pathogenic bacteria that have been linked to contamination of fresh fruit and vegetables are:

- *Salmonella species*
- *Escherichia coli (E. coli)*
- *Shigella species*
- *Listeria monocytogenes*

Bacteria such as Listeria monocytogenes can be found in the soil. The bacteria can survive up to 60 days in the soil. Produce contamination can be caused by soil contact with the edible part of the produce or contact with dirty containers and equipment.

Other bacteria such as Salmonella species, E. coli, and Shigella species reside in the intestinal tract of animals and humans. They can contaminate fruit and vegetables through the use of untreated animal manures, contaminated water, presence of animals in the production site and packing area, and humans handling produce.

Parasites

Parasites are organisms that live in another living organism, called the host. They are unable to multiply outside an animal or human host but can cause illness with only a low number of organisms.

Fruit and vegetables can act a vehicle to pass a parasite from one host to another – animal to human or human to human. Cysts, the dormant phase of parasites, can survive and remain infectious for up to seven years in the soil – for example Giardia.

Water contaminated with faecal material, infected food handlers and animals in the production site and packing area can be vehicles for contamination of produce with parasites.

Parasites most commonly associated with contaminated fruit and vegetables are:

- *Cryptosporidium*
- *Cyclospora*
- *Giardia*

Viruses

Viruses are unable to reproduce outside of a living cell and do not grow in or on fruit and vegetables. However, produce can act as a vehicle to pass viruses from animals to humans or from humans to humans. Low numbers of viruses on produce can cause illness.

Viruses that have been passed onto humans through contaminated produce are:

- Hepatitis A virus
- Norwalk virus and Norwalk-like virus.

Sources of biological contamination

Sources of biological contamination include:

- Soil
- Water
- Animal manure
- Sewage fluids
- Humans
- Animals
- Dust carried by air

Examples of contamination from biological hazards are listed in the following table.

Biological hazard	Sources of contamination
Pathogenic microorganisms on produce (bacteria, parasites, viruses)	• Animal faeces or and human sewage contaminating: - water used for irrigation, pesticide application, unloading harvesting containers, washing, top icing, hydrocooling, cleaning - soil that contacts the edible parts of produce - equipment, containers, tools, packaging materials, pallets or transport vehicles • Inadequate cleaning of harvesting (knifes, crates), grading and packing equipment and materials that are contaminated directly or indirectly (via soil, water) • Untreated animal waste used for fertilizing or soil improvement that contacts produce directly or indirectly • Handling of produce by infectious workers due to lack of clean toilet and hand washing facilities or poor personal hygiene practices and sickness (for example Hepatitis A virus)

Risk of biological contamination

The risk of contamination of fresh fruit and vegetables from pathogenic microorganisms varies with the following factors:

1. How the produce is grown
   - Produce grown in or close to the ground (lettuce) has a higher risk than produce grown well above the ground (mango).
   - Produce grown in frequent contact with water has a higher risk – for example hydroponic production.

2. The type of produce surface
   - Produce with a large uneven surface (lettuce) has a higher risk than produce with a smooth surface (cucumber).

3. How the produce is consumed
   - Produce eaten raw (salad greens) has a higher risk than cooked produce (potato).
   - Produce with an edible skin (star fruit) has a higher risk than produce with an inedible skin (banana).

2.3 Physical hazards

Physical hazards are foreign objects that can cause illness or injury to consumers. Contamination can occur during production, harvesting and postharvest handling.

Types of physical hazards and common sources of contamination are listed in the following table.

Hazards	Causes of contamination (examples)
Foreign objects from the environment – soil, stones, sticks, weed seeds	• Harvesting of ground crops during wet weather • Dirty harvesting containers and equipment, packing equipment, packaging materials • Stacking of dirty containers on top of produce
Foreign objects from equipment, containers, buildings and structures – glass, wood, metal, plastic, paint flakes	• Broken lights above packing equipment and uncovered produce • Damaged harvesting containers, harvesting and packing equipment, pallets • Inadequate cleaning, repairs and maintenance
Foreign objects from human handling of produce – jewellery, hair clips, personal items	• Careless or untrained workers • Inappropriate clothing

Figure 3. Physical hazards are foreign objects that become embedded in produce or fall into packages.

3. GAP requirements

The good agricultural practices for controlling food safety hazards are grouped into 10 elements. Each element has background information to explain how contamination can occur. Specific information is then provided for each practice to explain what is required to implement the practice. In some cases, two or more practices are grouped together as the guidance information is the same for both practices.

3.1 Site history and management

Selection of land for growing fruit and vegetables is an important consideration for production of safe produce. The biological and chemical history of the site prior to use for production must be considered. Soil can contain pathogenic microorganisms, persistent chemicals and heavy metals.

Biological contamination of the site can occur from pathogenic microorganisms present in the soil such as Listeria monocytogenes , Clostridium perfringens, Bacillus cereus, parasite cysts (Giardia, Cyclospora and Cryptosporidium) and some viruses. Some pathogens can survive for many years and some survive better in a moist environment and others survive well in dry soil. The survival of microorganisms in the soil is increased when they are protected by organic matter.

Figure 4. The risk of chemical and biological contamination of produce from previous use of the site and from adjoining sites must be assessed.

Chemical contamination of the site can arise from previous land use such as industrial use of the land, mining of the land, chemicals used in wars, and chemical residues from previous farming activities. Persistent organic and inorganic chemicals in the soil may pose risks to consumer health if produce becomes contaminated. Access to export markets can also be lost if contaminated produce is detected. In sites where a potential risk exists, soil testing should be undertaken to determine whether chemical residues are present.

The risk of contamination is higher for root and tuber vegetables and crops grown near or in contact with the ground, as soil present on the produce surface may contain persistent chemicals. 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. Picking of fallen produce (for example windfall fruit) should also be avoided to prevent surface contamination.

Heavy metals are the group of metals that are five or more times heavier than water. Examples are arsenic, cadmium, chromium, 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 heavy industrial uses (either past or present).

Maximum levels (MLs) for heavy metals in produce are usually specified in country food standard regulations. The potential risk of heavy metal uptake varies with crops and environmental conditions. For example, the risk of cadmium uptake is higher for root, tuber and leafy vegetables. 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.

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 and conditions to minimise heavy metal uptake.

Practice 1. *The risk of contaminating produce with chemical and biological hazards from the previous use of the site or from adjoining sites is assessed for each crop grown and a record is kept of any significant risks identified.*

The risk of contaminating produce is assessed by identifying the previous use of site and the likelihood of biological or chemical contamination of the soil leading to contamination of the produce to be grown. Prior uses that can be a source of contamination include:

- Storage of animal manure
- Intensive animal grazing
- Treatment or storage of human sewage and biosolids
- Treatment or storage of reclaimed water
- Dumping of excess chemicals
- Treatment with chemicals to control pests – for example treatment of the previous crop grown or treatment for antsaround structures and fences
- Landfill
- Industrial factory
- War zone

The present use of adjoining land also needs to be considered:

- Has it been used for landfill or waste?
- Has it been used recently for intensive animal production such as a feedlot?
- Do animals have access to this area?
- Does it have a septic sewage system and can it contaminate the proposed site?
- Is it a storage or dumping area for chemicals?
- Is it an industrial or urban site?

The risk of contamination varies with the produce type, so the assessment must be done for the intended crop to be grown on the site. A record of any significant risks identified must be kept. The information to record includes location of the site, type of produce to be grown, date of the assessment, who did the assessment and the results of the assessment. An example of a risk assessment is contained in Section 5. Examples of documents and records.

Practice 2. *Where a significant risk of chemical or biological contamination of produce has been identified, either the site is not used for production of fresh produce or remedial action is taken to manage the risk.*

If the risk of contaminating produce is significant, either avoid using the site until sufficient time has lapsed or remedial action has reduced the risk, or select another crop where the risk is low. For example, where the site was previously used for intensive animal grazing, spelling the site before planting salad greens would be required or another crop where the edible part is high above the ground could be grown.

Practice 3. *If remedial action is required to manage the risk, the actions are monitored to check that contamination of the produce does not occur and a record is kept of the actions taken and monitoring results.*

Decisions related to remedial action may require advice from a technical expert or regulatory authority. It is important to monitor whether the remedial action has been effective. For example, if uptake of cadmium in potatoes was excessive because the soil was acidic and low in organic matter, lime and organic products could be applied to reduce the mobilisation of cadmium in the soil. This remedial treatment should be monitored by measuring soil acidity and chemical residue analysis of the produce.

A record of the remedial actions taken and the monitoring results must be kept. This information can be recorded together with the information required for the risk assessment. An example of a risk assessment is contained in Section 5. Examples of documents and records.

Practice 4. *The location of any contaminated sites on the property, which are unsuitable for production of fresh produce, is recorded.*

A record of any contaminated sites on the property must be kept. This can be easily recorded on a property map. The map identifies the separate production sites, storage areas for chemicals, fertilisers and soil additives, water sources and storage sites, and buildings, structures and roads. Contaminated sites are marked on the map relative to this other information. Displaying the property map in a prominent area will help to inform workers of contamination areas.

3.2 Planting material

Planting material can be a source of chemical contamination through chemicals used to treat seeds or control pests during nursery production. To avoid excessive residues, only chemicals approved by a competent authority for use on the produce must be used and withholding periods observed.

Practice 5. *If planting material is produced on the farm, a record is kept of any chemical treatment used and the reason for use.*

The record of chemical treatment should include the produce type, location, chemical used, reason for application, date, rate and method of application, withholding period, and operator name. This information can be recorded in a log book or on a record form, and must be kept for future reference.

Practice 6. *If planting material is obtained from another farm or nursery, a record is kept of the name of the supplier and the date of supply.*

A record of the supplier and date of supply is kept in case contamination is detected during production or after harvest. The record enables the planting material to be traced to the supplier to investigate possible causes of the contamination. The record can be an entry into a log book or a delivery notice or receipt.

Practice 7. *Varieties known to be toxic for human consumption are not grown.*

Some varieties of fruit and vegetables may be toxic to humans – cassava for example. Check the suitability of the variety before planting any crop known to have varieties that are toxic to humans.

3.3 Fertilisers and soil additives

Chemical contamination of fresh produce can be caused by the presence of heavy metals (particularly cadmium) in low grade fertilisers and soil additives such as gypsum, animal manures, biosolids and composts. Root, tuber and leafy vegetables can take up cadmium if growing conditions are favourable for uptake. For other crops there is minimal risk of cadmium contamination.

Biological contamination of fresh produce can occur through the use of organic products. Untreated animal manure or improperly composted materials can contain high levels of pathogenic microorganisms. Contamination can occur through direct contact of the organic product with the edible part of the crop during soil or foliar application or indirectly through contamination of soil or water. Produce that is grown in or close to the ground has a higher risk of contamination than those grown well above the ground.

Practice 8. *The risk of chemical and biological contamination of produce from the use of fertilisers or soil additives is assessed for each crop grown and a record is kept of any significant hazards identified.*

The assessment must be done for each fertiliser or soil additive to be used and the intended crop to be grown on the site. A record of any significant risks identified must be kept. The information to record includes location of the site, type of produce to be grown, date of the assessment, who did the assessment and the results of the assessment. This information can be recorded in a log book or on a record form. An example of a risk assessment is contained in Section 5. Examples of documents and records.

Practice 9. *If a significant hazard from the use of fertilisers or soil additives is identified, measures are taken to minimise the risk of contamination of produce.*

The risk of chemical contamination can be minimised by using fertilisers and soil additives that are low in heavy metals or by growing crops where uptake of heavy metals is negligible. Always check the chemical analysis of the product before use.

Methods of minimising the risk of microbiological contamination from the use of organic products (commercial products or farm materials such as rice stalks, animal waste, and crop waste) are:

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 onto adjacent crops from wind drift or rainfall runoff.
- Maximise the period between the time of application of organic products and the time of harvest.
- Compost the organic product fully to reduce microbe levels.
- Do not apply untreated animal manure within 60 days of harvest if direct or indirect contact with the edible part of the crop may occur.
- For side-dressing produce grown close to the ground, use only fully composted materials or treated proprietary organic products, and do not apply them within 2 weeks of harvest.
- Avoid applying organic products (treated or untreated) over the top of produce.
- Do not allow grazing animals into growing crops within 60 days of harvest if direct or indirect contact with the edible part of the crop may occur.

Figure 5. For side-dressing produce grown close to the ground, use only fully composted materials or treated proprietary organic products, and do not apply them within 2 weeks of harvest.

Practice 10. Fertilisers and soil additives are selected to minimise the risk of contamination of produce with ` heavy metals.

Many fertilisers and soil additives are by-products of industrial processes and may contain other chemicals that are not required for plant growth. Only fertilisers and soil additives that comply with the legal or recommended limits for heavy metals and have the lowest available impurity levels should be used. For example, special low cadmium superphosphate fertilisers are now available and should be used where phosphorus application rates are high or where higher risk crops are grown.

Practice 11. Untreated organic materials are not applied in situations where there is a significant risk of contaminating the produce.

Situations where there is a significant risk of contaminating produce from using untreated organic materials include:

- applying untreated materials close to or after planting of produce grown close to the ground and eaten uncooked, and
- applying untreated materials to produce grown high above the ground during windy conditions.

Practice 12. Where an organic material is treated on the farm before application, the method, date and duration of the treatment are recorded.

Composting is a common method of treating organic materials. To ensure that composting is effective, the materials must be treated for at least 6 weeks and turned regularly to maintain the required temperature and moisture through the heap. To prove that the materials have been effectively treated, a record is kept of the treatment method, date and duration. The information can be recorded in a log book or on a record form and must be kept for future reference.

Practice 13. *If a product containing organic materials is obtained from off the farm and there is a significant risk of contaminating the produce, documentation is available from the supplier to show that the material has been treated to minimise the risk of contaminating the produce.*

Examples of high risk situations are described under Practice 11. Documentation from the supplier showing that the materials have been treated can be a product label, specification sheet, letter or statutory declaration. The documentation must be kept for future reference in case contamination is detected during production or after harvest. The record enables the organic material to be traced to the supplier to investigate possible causes of the contamination.

Practice 14. *Human sewage is not used for production of any fresh produce destined for human consumption.*

Human sewage may contain pathogenic microorganisms and should not be used to grow fresh produce. In some countries, biosolids are produced during the biological treatment of sewage. Biosolids must also not be used as they present risks that have not been properly researched.

Practice 15. *Equipment used to apply fertilisers and soil additives is maintained in working condition and checked for effective operation at least annually by a technically competent person.*

Faulty operation of equipment may lead to excessive application of fertilisers and soil additives. Equipment must be checked by a technically competent person at least annually to ensure that application rates are within the acceptable range. A technically competent person can be the farmer or a worker who is skilled in operating the equipment or an adviser such as a representative from the equipment supplier.

Equipment used for composting, storing and applying organic materials should not be used for other tasks where contact with produce may occur.

Practice 16. *Areas or facilities for storage, mixing and loading of fertilisers and soil additives and for com posting of organic materials are located, constructed and maintained to minimise the risk of contamination of production sites and water sources.*

Biological and chemical contamination from rainfall runoff or wind drift may occur if areas or facilities for storage, mixing and loading of fertilisers and soil additives and for composting of organic materials are located close to production sites and water sources. These areas and facilities need to be constructed with barriers, drainage systems, and covers to prevent direct or indirect contamination of produce.

Figure 6. The location of organic materials beside waterways used to irrigate or wash produce can lead to biological contamination of produce.

Practice 17. *A record of fertilisers and soil additives obtained is kept, detailing the source, product name, and date and quantity obtained.*

Practice 18. *The application of fertilisers and soil additives is recorded, detailing the date, name of the product or material used, treatment location, application rate, application method, and operator name.*

A record of fertilisers and soil additives obtained and applied must be kept for traceability in the event of contamination being detected during production or after harvest. The records enable possible causes of the contamination to be investigated.

The information on the source, date, quantity and product or materials obtained can be recorded in a log book or on a record form or a copy of the delivery receipt can be kept.

The record of the application of fertilisers and soil additives can be recorded in a log book or on a record form. An example of record form is contained in Section 5. Examples of documents and records.

3.4 Water

Water is used during growing for irrigation, fertigation and spraying of produce, and after harvest for washing of produce and equipment, 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.

Water can be contaminated with chemical and biological hazards. Chemical contamination can occur through dumping or spillage of chemicals into water sources or run-off of chemicals into water sources from adjacent sites.

Pathogenic organisms that can be present in water include bacteria such as *Salmonella* species, *E. coli*, and *Shigella* species, parasites such as *Cryptosporidium, Giardia* and *Cyclospora*, and viruses such as Hepatitis A virus and the Norwalk virus. Most of these organisms are of faecal origin, and commonly found to inhabit mammals such as cattle, sheep and poultry. Animal grazing near water supplies, uncontrolled access of livestock or wildlife and inappropriate storage of manure can potentially contaminate water sources.

The risk of contaminating produce from water contaminated with chemical or biological hazards varies with the source of the water, when and how the water is used and the type of produce.

Source of water. Water is commonly sourced from waterways (rivers and streams), lakes, reservoirs, dams, bores and storage tanks, and may be contaminated by microorganisms or chemicals.

- Water from waterways may be contaminated with microorganisms 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 release chemicals into water sources.

- Water from dams may be contaminated by microorganisms 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 are close to the dam or waterway.

- Water from bores may be contaminated by microorganisms from seepage from septic systems or from heavily grazed catchment areas.

- Water storage tanks (commonly use for rainfall storage) and pipes may be contaminated by microorganisms from bird, rodent 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.

Use of water. The risk of biological contamination is higher if the water is applied to the edible parts of produce immediately before harvest or after harvest during handling and packing. This may include overhead irrigation and sprays applied just before harvest, wash water, water in post-harvest chemical dips and sprays, water in unloading tanks and troughs, water in hydro-coolers and water used for top icing of packages. Irrigation water that does not contact produce, such as drip or trickle irrigation, is of low risk.

The risk of contamination is greater when water is recycled and not adequately treated or maintained, particularly for washing produce. The final water applied after harvest to the edible parts of produce should be equivalent to potable water standard (drinking quality according to WHO standards).

The quality of the water used for washing hands and cleaning surfaces or equipment that directly contact produce also needs to be assessed for potential risk of contamination.

Spray irrigation

Trickle irrigation

Figure 7. The risk of biological contamination higher for spray irrigation than trickle irrigation where water does not contact the edible part of produce.

Type of produce. The type of produce, its edible part and the way produce is consumed affects the risk of biological contamination. The risk is higher for produce with large uneven surfaces such as leafy vegetables that can trap moisture and microorganisms than produce with smooth skins. If produce is eaten raw, the risk is higher compared to produce that is peeled or cooked before eating.

Practice 19. *The risk of chemical and biological contamination of produce is assessed for water used before harvest for irrigation, fertigation, and applying chemicals, and after harvest for handling, washing, produce treatment, and cleaning and sanitation. A record is kept of any significant hazards identified.*

For each type of produce grown, the risk of chemical and biological contamination from using water must be assessed. Aspects to consider are:

- What is the source of water and is it likely to be contaminated?
- How is the water applied and does it contact the edible parts?
- How is the produce consumed? Is it eaten raw or peeled or cooked before eating?

Generally surface water presents higher risk of contamination than groundwater, as it may come from some distance and control of possible sources of contamination may not be possible. Factors affecting contamination include animals grazing upstream, manure application to land, rainfall patterns and topography. The slope of the land and rainfall may allow contaminated run-off to reach surface waters.

Adjacent operations such as landfill sites, septic tanks, compost producers, and dairy and poultry farms may be a source of contamination. In these cases, physical barriers such as ditches, fences, vegetative buffers and a catch pond should be constructed.

Water that is applied to the edible part of produce presents a higher risk than when there is no contact. For example, the risk of contaminating produce from using trickle irrigation is low because the water does not contact the edible parts. Where contact with the edible part does occur during irrigation or spraying, the risk of contamination is highest the water is used close to harvest – typically within 2 days of harvest.

The risk of contamination is higher for produce that is eaten raw, particularly produce with large uneven surfaces such as salad greens. Large uneven surfaces can trap moisture and microorganisms.

A record of any significant risks identified must be kept. The information to record includes the location of the site, type of produce to be grown, date of the assessment, who did the assessment, measures taken to minimise the

risk and the results of the assessment. This information can be recorded in a log book or on a record form. An example of a risk assessment is contained in Section 5. Examples of documents and records.

Practice 20. *Where water testing is required to assess the risk of contamination, tests are conducted at a frequency appropriate to the conditions impacting on the water supply, and a record of test results is kept.*

It is impractical to test water for every possible pathogenic microorganism. Testing for the presence of a group of bacteria called faecal coliforms will give an indication of biological contamination. They are also known as thermotolerant coliforms because they can tolerate high temperatures (up to 45°C).

Water for testing should be sampled at the point where it contacts produce. The test should be done at times when the likelihood of contamination is highest and at a frequency that allows management of the potential risk. As a rule, water should be tested when the condition of the source changes. For example, water sourced from dams and waterways is more likely to be influenced by run-off into catchments following rain, than water from deep underground bores.

Water samples should be analysed by a laboratory that is recognised by a competent authority. Before sending water samples, contact the laboratory for instructions on how to collect and transport the water samples to the laboratory.

The critical limits for levels of faecal coliforms in water depend on the type of produce, how the water is used and whether the organisms will survive on the produce. A guide for critical limits for produce eaten uncooked and where water contacts the edible part is shown in the table below. Methods commonly used to test water can not detect levels of faecal coliforms below 10 colony forming units (cfu) per 100 ml of water.

Water use	**Critical limit for faecal coliforms** (number per 100 ml of water)
Irrigation, fertigation	1000
Spraying chemicals close to harvest, water dumps, hydrocoolers	100
Wash water, produce treatment, equipment cleaning, hand washing, top-icing	10

Routine testing of water for chemical contamination is not required and should only be done where chemical contamination of the water is suspected. For example, if spillage of chemicals into the waterway used for washing produce occurs near the farm.

A record of the test results must be kept. The information to record includes source of the water, sampling location, and the date and results of the test. This can be easily achieved by recording the date, water source and sample location on the test results supplied by the laboratory.

Practice 21. *Where the risk of chemical and biological contamination of produce is significant, either a safe alternative water source is used or the water is treated and monitored and a record is kept of the treatment method and monitoring results.*

Water can be treated to reduce the levels of pathogenic microorganisms present but treatment of water for chemical contamination is not practical. Where chemical contamination has occurred, a safe alternative water source should be used.

Figure 8. Water used to wash produce that is consumed without cooking must be treated and monitored for effectiveness to minimise the risk of biological contamination.

There are a number of chemical and non-chemical sanitising methods that can be used to treat water for biological contamination. Chemical sanitisers must be approved for use by a competent authority. Technical advice should be sought to ensure that the best option is used for the targeted microorganism. Common options are:

- 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 the biological loads. These include:

- the type of produce,
- the type of microorganisms present,
- the number of microorganisms 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, and
- the concentration of the sanitiser.

Water sanitation must be monitored to check that the treatment is working effectively. The type of monitoring will depend on the treatment method. For example for chlorine treatment, the pH of the water needs to be regularly monitored as the effectiveness of chlorine is reduced above a pH of 7.5. Organic matter in the water binds up chlorine and makes it inactive. Regular monitoring of the water using test strips is required to check that free chlorine is present.

To check for faecal contamination of produce, testing for the presence of the indicator organism *E. coli* is used. Testing for faecal coliforms is not suitable as some are spoilage microorganisms and their presence poses no risk to human health.

A record of the treatment method and monitoring results must be kept. The information to record includes source of the water, type of sanitiser used, date and time of treatment, and the date, time and results of monitoring. The information can be recorded in a log book or on a record form.

Practice 22. *Untreated sewage water is not used during production and postharvest handling of produce. In countries where the use of treated water is permitted, the water quality must comply with the relevant regulations.*

Reclaimed sewage water can contain pathogenic microorganisms and should not be used without treatment. Any use of treated reclaimed water must follow country specific regulations. If the use of treated reclaimed water is permitted, the level of treatment must be high to prevent potential hazards.

3.5 Chemicals

Agrochemicals

Chemicals are used during the production of fresh produce for control of pests (pesticides), regulation of growth and thinning of crops, and after harvest for treating produce for disease control or insect disinfestation, applying surface coatings to reduce moisture loss or improve appearance, and for sanitising water and equipment surfaces. To avoid excessive residues, chemicals must be approved for use on the type of produce grown and must be stored and applied according to label or permit instructions.

Practice 23. *Employers and workers have been trained to a level appropriate to their area of responsibility for chemical use.*

Incorrect selection, mixing, and application of chemicals can lead to residues exceeding the MRL. Training is important to ensure that managers and workers have the appropriate level of knowledge and skills, which may vary with area of responsibility. For example, the person who has overall responsibility for chemical use must have knowledge about all aspects and be able to train workers. A worker who applies the chemical must have knowledge and skills on preparing the formulation and the operation of equipment.

Source: Mr. S. Menon, QA Plus Asia-Pacific Sdn. Bhd., Malaysia

Figure 9. Employers and workers must be trained to a level appropriate to their area of responsibility for chemical use.

Evidence is required to show that people have been trained to the appropriate level. This may vary from a certificate from a formal training course to a note in a log book. The information to record is the person's name, date of training and topics covered.

Practice 24. *If the choice of chemical products is made by advisers, proof of their technical competence is available.*

Advisers used to select chemicals must show proof of their competence. Examples of proof are qualifications from an education institution, statement of knowledge and experience from a competent authority, and a training course certificate.

Practice 25. *Integrated pest management systems are used where possible to minimise the use of synthetic chemicals.*

An integrated pest management (IPM) system integrates multiple strategies for managing pests to minimise the use of synthetic pesticides. The strategies include encouraging beneficial insects and microorganisms to flourish, good crop hygiene and plant health, regular monitoring of crops for pests, using biological control agents, and selective use of synthetic pesticides.

Evidence is required to show that an IPM system is used. Examples of evidence are records of crop protection practices such as pest monitoring results, use of biological control agents, and spray application.

Practice 26. *Chemicals are only obtained from licensed suppliers.*

Chemicals obtained from unlicensed suppliers may be incorrectly identified or not true to the label contents or may contain impurities, which may lead to the use of unapproved chemicals or excessive residues.

Most countries have authorities responsible for registering the use of chemicals on farms and for setting and monitoring chemical MRLs. In some countries one authority may be responsible for both functions and in others the functions may be the responsibility of separate authorities. Approval to use the chemical may be listed on the label or a permit may be issued for its use.

Practice 27. *Chemicals and biopesticides used on crops are approved by a competent authority in the country where the crop is grown and intended to be traded, and documentation is available to confirm approval.*

Practice 28. *Up to date information on chemical MRL standards for the country where produce is intended to be traded, is obtained from a competent authority.*

Chemicals are typically approved for a particular purpose for specified crops. The approved use and MRL must be confirmed for not only the country where the produce is grown but also for where the produce is intended to be traded. It is possible that a chemical may be approved with a particular MRL in the country where the produce is grown but is banned or has a different MRL where the produce is to be traded. Biopesticides , which are made from biological sources, must also be approved for use on the produce grown.

Documented lists of approved chemicals and MRLs can be obtained from publications or downloaded from web-sites or direct contact with the appropriate authorities. The Codex Alimentarius Commission (www.codexalimentarius.net) provides standards for MRLs that many countries have adopted.

Figure 10. Chemicals and biopesticides used on crops must be approved by a competent authority in the country where the crop is grown and intended to be traded.

Practice 29. *Chemicals are applied according to label directions or a permit issued by a competent authority.*

To prevent residue levels exceeding the MRL in the country where produce is intended to be traded, chemicals must be applied according to the label or permit directions. Excessive residues can occur if mixing is incorrect, the application rate is too high or the withholding period is not observed. Labels that are written in a foreign language must be translated accurately to ensure that mixing and application rates are correct and withholding periods are followed.

If there is no MRL established for a chemical in the country where produce is to traded, the detection of any trace amounts of the chemical will result in the consignment being withdrawn from sale.

Practice 30. *To check that chemicals are applied correctly, produce is tested for chemical residues at a frequency required by customers or a competent authority in the country where produce is intended to be traded. The laboratory used is accredited by a competent authority.*

Testing produce to check 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 to the produce. However,

standard analysis methods may include a broad range of MRLs at a cost effective price, and these are now commonly used for chemical residue testing. Alternatively, a pesticide that poses the highest risk for exceeding the MRL can be selected for testing.

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

- chemicals applied frequently 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 highly toxic to humans,
- chemicals applied after harvest, and
- chemicals from possible spray drift.

The frequency of residue testing is usually specified by the customer or a government authority in the country where produce is intended to be traded. This may be annual or more frequent. A reduced frequency may be allowed once a successful record of compliance is established.

The produce may be sampled for testing by the farmer prior to dispatch or by a wholesaler or exporter or importer or retailer or a competent authority on arrival at the destination. If the postharvest application of chemicals for long-term storage is being checked, then produce should be sampled after storage. The sample must be unbiased and representative of the produce supplied.

The Codex Alimentarius Commission provides guidelines on the sampling method for testing MRLs (refer to www.codexalimentarius.net). A summary of these guidelines is provided below.

Produce type	**Examples**	**Minimum quantity**
Small or light produce, unit weight up to about 25 grams	strawberry, pea, olive, parsley	1 kilogram
Medium sized produce, unit weight usually between 25 and 250 grams	apple, orange, carrot, potato	1 kilogram (at least 10 units)
Large sized produce, unit weight over 250 grams	cabbage, watermelon, cucumber	2 kilograms (at least 5 units)

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

- use disposable gloves or thoroughly wash hands before collecting the sample;
- place the sample in a clean plastic bag and a box to protect it during transport;
- clearly label the sample with name, address, telephone number and record the date of sample collection and the location point where it was collected;
- clearly indicate the types of chemicals required for testing;
- store the sample in a cool but not frozen state until ready to transport; and
- avoid long delays to ensure the sample gets to the laboratory promptly.

Choose a laboratory that is technically competent in analysing chemical residues in fresh produce and has accreditation from a competent authority.

Practice 31. The mixing of more than two chemicals is avoided, unless recommended by a competent authority.

Mixing of chemicals can cause chemical reactions that may change the active ingredients and lead to excessive MRLs in the produce. The compatibility of chemicals is often known for mixes of two chemicals but usually unknown for mixes of three or more chemicals. Chemicals should only be mixed if information on compatibility is available from a competent authority.

Practice 32. Withholding periods for the interval between chemical application and harvest are observed.

The withholding period is the time that must be observed between the application of a chemical and the time of harvest. The withholding periods vary between chemicals. If a chemical is applied inside the withholding period, residues may exceed the MRL and lead to withdrawal of the produce from sale. Information on the withholding period can be obtained from the label or permit or from publications and websites of a competent authority.

Practice 33. *Equipment used to apply chemicals is maintained in working condition and checked for effective operation at least annually by a technically competent person.*

Faulty equipment may lead to excessive application rates of chemicals and residues exceeding the MRL. During each use, the equipment should be checked for leaks and faulty nozzles. At least annually, the equipment should be calibrated to check that the volume of spray delivered is correct. The calibration must be done by a technically competent person. This can be the farm owner, a farm worker, an advisor, or an equipment representative as long as they have been appropriately trained.

A record of the calibration should be kept. The information to record includes the name of person who did the calibration and the date and results of the calibration. The information can be recorded in a log book or on a record form.

Practice 34. *Equipment is washed after each use and washing waste is disposed of in a manner that does not present a risk of contaminating the produce.*

Practice 35. *Surplus application mixes are disposed of in a manner that does not present a risk of contaminating the produce.*

Application mixes left in equipment can lead to excessive chemical residues on produce, particularly where more than one type of produce is grown. A chemical approved for application to one crop may not be approved for another crop. If the equipment is not cleaned properly, residues from the unapproved chemical may be present on the next crop sprayed.

The waste water from cleaning equipment and surplus application mixes must be disposed of in a manner that doesn't lead to excessive residues on produce. The waste water or surplus mix may be applied to a crop for which the chemical is approved, provided it is applied according to the label or permit directions. It may also be applied to an area when there is no risk of the chemical directly contacting produce or indirectly through contamination of a water source.

Practice 36. *Chemicals are stored in a well lit, sound and secure structure, with only authorised people allowed access. The structure is located and constructed to minimise the risk of contaminating produce and equipped with emergency facilities in the event of a chemical spill.*

Incorrect and careless storage and handling of chemicals can lead to the contamination of produce either directly through accidental spillage or indirectly through contamination of water, equipment, containers and packaging materials that come into contact with produce.

To minimise the risk of contamination, chemicals must be stored in a well lit, sound and secure structure with access restricted to authorised people. The structure must be located in an appropriate place, constructed to protect the chemicals from weather exposure, and equipped with emergency facilities to contain spillages. The structure may be stand alone or located inside another building. For example if small quantities of chemicals are stored, a locked cupboard with shelves would be a suitable structure provided it is segregated from packing, storage and handling areas.

Measures to minimise the risk of contamination include:

- Locate the structure away from water sources and where the risk of flooding is high
- Use a cool, waterproof structure that keeps chemicals out of direct sunlight and severe weather exposure.
- Use an impervious floor (for example concrete), with bunding around the floor to contain any spills or leaks and also prevent water entering.
- Install lighting so that chemical labels can be read clearly.
- Keep the structure locked to ensure that children and unauthorised people are kept out.
- Keep a spill kit (shovel and dry sand or soil) in a clearly visible and accessible area.

- Do not store pesticides with chlorine or fertilisers containing ammonium nitrate, potassium nitrate or sodium nitrate as spillage may cause explosions.

Figure 11. Chemicals must be stored in a well lit, sound and secure structure, with only authorised people allowed access.

Practice 37. *Liquid formulations of chemicals are not stored on shelves above powders.*

If liquids formulations are stored above powders, spillage and leakage can lead to contamination of chemical powders below. The liquid chemical may not be approved for the same crops as the chemical powder, which will result in unacceptable residues if the contaminated chemical powder is used. Reactions between the chemicals may also occur to produce new chemicals that are not approved for application to the specified crops.

It is also good practice to have separate areas within the structure for storing insecticides, fungicides, herbicides, and other chemicals to avoid accidental use of the wrong chemical.

Practice 38. *Chemicals are stored in the original container with a legible label and according to label directions or instructions from a competent authority. If a chemical is transferred to another container, the new container is clearly marked with the brand name, rate of use and withholding period.*

A chemical must be stored in the original container with a legible label to avoid using the wrong chemical or application rate or withholding period. The only occasion when a chemical should be transferred to another container is when the original container is damaged. The new container must be marked with the chemical brand name and information from the original label must be available to prevent incorrect use.

Practice 39. *Empty chemical containers are not re-used and are kept secure until disposal.*

Practice 40. *Empty chemical containers are disposed of according to relevant country regulations and in a manner that minimises the risk of contaminating produce. Official collection and disposal systems are used where available.*

Empty containers may be a source of chemical contamination, especially when not triple washed to remove all traces of chemical. Triple washing involves rinsing the empty containers three times with clean water. Empty containers must not be re-used for storing other chemicals or produce. They must be kept secure until disposal to avoid accidental use. Some countries have regulations covering the disposal of empty containers through official collection and disposal systems.

Source: Mr. Baharudding Abdul Manap,Department of Agriculture, Malaysia

Figure 12. Empty chemical containers are not re-used and are kept secure until disposal.

Practice 41. *Obsolete chemicals that are unusable or no longer approved are clearly identified and kept secure until disposal.*

Practice 42. *Obsolete chemicals are disposed of through official collection systems or in legal off-site areas.*

The age of a container of chemical can be determined from the expiry date or manufacture date on the container. A rule-of-thumb is that active ingredients begin to deteriorate 2 years after manufacture. Regulatory approvals for chemicals can also change.

An annual check of chemicals in storage will ensure that these chemicals have current approval, are still within their expiry date and the containers are intact with readable labels. This will ensure that the application of chemicals will not exceed the MRLs, the chemicals are still effective, and the containers are and not mixed up.

If a chemical is found to be obsolete, it must be clearly identified and kept secure until disposal. This can be achieved by marking the container with the words “obsolete” and placing it in a designated area for obsolete chemicals, which may be inside the storage structure.

To avoid direct or indirect contamination of produce on the farm, obsolete chemicals must be disposed of through official collection systems or in legal off-site areas.

Practice 43. *The application of chemicals is recorded for each crop, detailing the chemical used, reason for application, treatment location, date, rate and method of application, withholding period, and operator name.*

Practice 44. *A record of chemicals obtained is kept, detailing chemical name, supplier of chemical, date and quantity obtained, and expiry or manufacture date.*

Practice 45. *Where applicable, a record of chemicals held in storage is kept, detailing chemical name, date and quantity obtained and date when completely used or disposed of.*

A record of chemicals obtained, applied and stored must be kept to show that chemicals have been applied and stored correctly and for traceability in the event of contamination being detected during production or after harvest. The records enable possible causes of the contamination to be investigated.

The information required can be recorded separately or together in a log book or on a record form. A copy of the delivery receipt can also be kept as a record of chemicals obtained. Examples of records for obtaining, storing and applying chemicals are contained in Section 5. Examples of documents and records.

Practice 46. *If chemical residues in excess of the MRL are detected in the country where produce is traded, marketing of the produce is ceased. The cause of the contamination is investigated, corrective actions are taken to prevent re-occurrence, and a record is kept of the incident and actions taken.*

If chemical residues in excess of the MRL are detected, marketing of the produce must cease immediately. The cause of the contamination is investigated by tracing the consignment back to the farm and identifying the points where contamination may have occurred. Possible causes of excessive chemical residues are:

- use of unapproved chemical for target crop,
- incorrect mixing or overdosing,
- withholding period not observed,
- spraying equipment faulty or not calibrated or not cleaned properly after the last use or multi-purpose use of equipment,
- spray drift from adjacent sites,
- chemical residue in soil from previous use,
- chemical residue in harvesting crates, and
- improper dumping, accidental spillage or seepage of chemical into soil or water source due to poor storage conditions.

Corrective actions must be taken to prevent re-occurrence of the problem. Examples of corrective actions are retraining workers, calibrating equipment, and building a new storage structure. A record of the incident and actions taken must be recorded to show that the farm has a system in place to fix problems. It also helps to review problems that have occurred in the past. The information required can be recorded in a log book or on a record form.

Other chemicals

Practice 47. *Fuels, oils, and other non-agrochemicals are handled, stored and disposed of in a manner that minimises the risk of contaminating produce.*

A number of chemicals other than agrochemicals may be used on farms and can either directly or indirectly contaminate produce. Examples are lubricants, fuels, cleaners, sanitisers, pest control chemicals, fertilisers, and adhesives. Possible causes of contamination are:

- inappropriate chemicals used for cleaning and sanitation or used at wrong dosage,
- accidental application of chemicals – for example, pest control chemicals sprayed near produce or packaging materials,
- chemicals spills near produce or leakage during storage or transport with produce, and
- oil leaks, grease, paint on equipment in contact with produce

Careful handling, storage and disposal of these chemicals is required to minimise the risk of contamination.

3.6 Harvesting and handling produce

Chemical, biological and physical contamination of produce can occur during harvesting and handling after harvest through:

- dirty and poorly maintained equipment, materials, containers, handling and storage areas, and transport vehicles,
- poorly constructed and maintained buildings and structures,
- use of non-approved chemicals for treating produce and cleaning and sanitising of equipment and work areas,
- inadequate control of domestic and farm animals and pests, and
- poor personal hygiene facilities and standards.

Equipment, containers and materials

Any equipment, container or other material that contacts produce during harvesting, handling, packing and storage of produce can be a source of chemical, biological and physical contamination. Contamination may occur due to poor cleaning and maintenance or inappropriate use of equipment, containers and materials.

Equipment, containers and materials includes baskets, buckets, bags, bulk bins, plastic crates, wooden boxes, bunch covers, harvest aides, knives, secateurs, packing line machinery, tables, benches, fibreboard cartons, packaging materials, and others.

Practice 48. *Equipment, containers and materials that contact produce are made of materials that will not contaminate produce.*

Equipment, containers and materials that contact produce must be made from materials that are non-toxic and free of pathogenic microorganisms. Inert materials such as wood, plastic, paper, and steel are suitable provided there is no risk of contamination from chemicals used to treat these materials. Materials made from organic substances such as straw should be treated to minimise the risk of contamination from pathogenic microorganisms.

Equipment and containers should be constructed to enable easy cleaning. Dirt can collect in areas that are difficult to clean such as the corners of containers.

Practice 49. *Containers used for storage of waste, chemicals, and other dangerous substances are clearly identified and are not used for holding produce.*

Contamination of produce can occur if containers used for holding produce are also used for storing waste, chemicals and other dangerous substances. Containers must be clearly identified to show the purpose for their use. For example, the use of containers can be identified by a particular style or material or colour or marked with a sign or code.

Practice 50. *Equipment and containers are regularly maintained to minimise contamination of produce.*

Poorly maintained equipment and containers can be a source of chemical or physical contamination. Chemical contamination can occur through fuel, oil and grease leaking from equipment parts. Physical contamination can occur through shavings and splinters (iron, wood, plastic) from equipment and containers penetrating into the produce. Regular maintenance must be carried out to check for and remove sources of contamination.

Figure 13. Equipment and containers must be regularly maintained to minimise contamination of produce.

Practice 51. *Equipment, containers and materials are stored in areas separated from chemicals, fertilisers and soil additives and measures are taken to minimise contamination from pests.*

Storage of chemicals, fertilisers and soil additives close to equipment, containers and materials can lead to contamination of produce through accidental spillage. These products must be stored in locations away from equipment, containers and materials that contact produce.

Pests such as rodents and birds can contaminate equipment, containers and materials with faeces. Measures used to minimise biological contamination from pests include using baits and traps, stacking containers and materials off the floor and ground, using dry and well lit storage areas, and covering equipment, containers and materials when they are not in use.

Practice 52. *Equipment, containers and materials are checked for soundness and cleanliness before use and cleaned, repaired or discarded as required.*

Despite every effort to maintain and store equipment, containers and materials effectively, contamination may still occur from contact with dirt, water, faeces, chemicals, fertilisers, soil additives and others. The risk of contaminating produce can be reduced by checking equipment, containers and materials before use for soundness and cleanliness and cleaning or repairing as required. If cleaning or repairing can not remove the potential source of contamination, the equipment, container or material must be discarded.

Practice 53. *Harvested produce is not placed in direct contact with soil or the floor of handling, packing or storage areas.*

Once produce is harvested, it should not be placed in direct contact, particularly the cut surfaces, with the ground or the floor of handling, packing and storage areas. Soil and dirty floors can be a source of biological contamination. The cut surfaces of produce can provide entry points and nutrients for pathogenic microorganisms.

Materials such as paper, plastic and timber can be placed on the ground or floor to prevent contact of harvested produce with dirt and other matter. The materials should be clean to prevent them being a source of contamination.

Figure 14. Materials such as paper can be placed on the soil to prevent contact with the edible parts of harvested produce.

Buildings and structures

Buildings and structures used for growing, packing, handling and storage can be a source of chemical, biological and physical contamination. The source of the contamination may be:

- the materials used for construction,
- lubricants, fuel, machinery, equipment and tools stored and used within the building and structure,
- sewage, waste disposal and drainage systems, and
- lights above areas where produce, packing containers and materials are exposed.

Practice 54. *Buildings and structures used for growing, packing, handling and storage of produce are constructed and maintained to minimise the risk of contaminating produce.*

Buildings and structures include tunnels and glasshouses used for protected cropping systems and covered areas for packing, handling and storing produce such as canopies, lean-tos, and sheds. Contamination of produce can be caused by toxic chemicals dripping from ceilings, foreign objects falling from deteriorating parts, and pathogenic microorganisms from a build up of dirt and dust.

The need for a durable and easy to clean floor, walls and ceilings should be considered during construction. Chemicals used during construction and maintenance such as paint and pest control chemicals must be carefully applied to avoid contamination of the produce.

Regular maintenance is required to prevent physical hazards from deteriorating parts from dropping into produce or packages. Examples of physical hazards are paint and rust flakes and iron and wood fragments.

Practice 55 *Grease, oil, fuel and farm machinery are segregated from handling, packing and storage areas to prevent contamination of produce.*

Grease, oil, fuel, and farm machinery must be stored away from areas used for handling, packing and storage of produce. They may be stored in the same building and structure as produce but must be physically separated to avoid contamination from accidental spillage.

Practice 56. *Sewage, waste disposal and drainage systems are constructed to minimise the risk of contaminating the production site and water supply.*

Sewage, waste disposal and drainage systems can be a source of chemical and biological contamination. Water runoff from sewage and waste disposal areas may contain pathogenic microorganisms and chemicals, which can cause contamination of production sites and water sources. Particular care must be taken with disposal of sewage, waste materials and produce and chemicals used to treat produce.

Practice 57. *Lights above areas where produce and packing containers and materials are exposed, are either shatter proof or protected with shatter proof covers. In the event of a light breaking, exposed produce is rejected and equipment and packing containers and materials are cleaned.*

The breaking of lights above where produce and packing containers and materials are placed can cause physical contamination. Breakage of lights can be caused by faulty manufacture, excess heat, and accidental contact during handling of equipment. To avoid physical contamination, lights must be made of shatter proof material or protected with shatter proof covers.

In the event of an unprotected light breaking, uncovered produce must be rejected and equipment and packing containers and materials must be cleaned. Supervisors should check areas below the broken light to ensure that cleaning has been effective.

Practice 58. *Where equipment and tools that may be a source of physical hazards are located in the same building as produce handling, packing and storage areas, the equipment and tools are screened with a physical barrier or are not operated during packing, handling, and storage of produce.*

Equipment and tools can be a source of physical contamination through splinters and shavings imbedding into produce or packing containers. They may be located in the same buildings and structures as the produce, provided they are screened with a physical barrier or not operated during packing, handling and storage of produce. Physical barriers can be temporary such as hessian blinds or sheets or permanent walls.

Cleaning and sanitation

Cleaning and sanitation minimises the risk of contaminating produce. All equipment, tools, containers and materials that come in contact with produce, and areas where produce is handled, packed and stored should be regularly cleaned and possibly sanitised. The method and frequency of cleaning and sanitation will depend on the type of produce and how it is handled, packed and stored, and how often the equipment, container or area is used.

Cleaning and sanitation are two distinct practices that require different methods. Cleaning is the physical removal of soil, dust, grease, oil, chemicals, and foreign objects. It reduces the number of microorganisms attached to these substances but does not kill the remaining microorganisms. Examples of cleaning methods are using high pressure cold and hot water with and without detergents and scrubbing with brushes and rags.

Sanitation follows cleaning and is designed to significantly reduce the number of remaining viable microorganisms on the surface. Types of sanitisers include chlorine agents, iodine compounds, quaternary ammonium chloride compounds, peroxy compounds, acid anionics, and carboxylic acids.

The effectiveness of a sanitiser is affected by:

- cleanliness of surface,
- ability of sanitiser to directly contact the surface,
- temperature and pH of sanitising solution,
- contact time,
- sanitiser concentration
- chemical composition of water used with sanitiser,
- number and types of microorganisms on surface, and
- possible interaction of sanitiser with other chemicals used (fungicides for example).

Practice 59. *Packing, handling and storage areas and equipment, tools, containers and materials that may be a source of contaminating the produce are identified, and instructions are prepared and followed for cleaning and sanitation.*

Potential sources of contamination include:

- equipment and tools used during harvesting such as knives, secateurs, and conveyors,
- containers used to transfer or store produce during any step,
- transport equipment and vehicles used in the field and packing and storage areas and for transferring produce in the supply chain,
- equipment used for grading, treating, handling, packing, cooling and storage of produce
- buildings and structures where produce is packed, handled and stored, and
- staff facilities.

Figure 15. Instructions must be prepared and followed for cleaning and sanitation of packing, handling and storage areas.

The items and areas that require cleaning and sanitation and the frequency and method of cleaning and sanitation must be identified and documented in written instructions. For some produce, cleaning may only be required while for others sanitation may be needed. Factors to consider are:

- Type of produce – contaminated produce that is eaten raw presents higher risk of causing food poisoning than produce that is cooked or protected by a skin that is removed before eating.
- Potential for direct contact with produce – for example, containers, tables and other surfaces that directly contact produce require more frequent cleaning and sanitising than walls and ceilings of buildings and structures.
- Potential for indirect contact – for example the build up of dirt and produce waste on the floor near where produce is packed presents higher risk than the same build up away from the packing area.

- Cleanliness of harvested produce and items and areas requiring cleaning and sanitation – for example some batches may contain more leaf litter than others or during wet weather more soil is likely to be present on produce, containers and equipment.
- Ability to control movement and flow of equipment, vehicles and people.
- Quality of water used for cleaning and sanitation.

Instructions for cleaning and sanitation should describe the equipment, tools, containers, vehicles, facilities and areas to be cleaned or sanitised, the frequency and methods, and the people responsible for doing the task. An example of a cleaning and sanitation instruction is contained in Section 5. Examples of documents and records. Supervisors should check the effectiveness of cleaning and sanitation at appropriate frequencies.

Practice 60. *Appropriate cleaning and sanitation chemicals are selected to minimise the risk of these chemicals causing contamination of produce.*

To avoid chemical contamination, cleaning and sanitation agents must be appropriate for use on surfaces that directly or indirectly contact produce. It is also important to use products according to the manufacturer's instructions and safety precautions. For example, there may be rinsing steps in cleaning and sanitising or specific methods of use where areas need to be kept dry.

Animals and pest control

Domestic and farm animals and pests such as rodents, insects and feral animals and birds can be a source of biological contamination either through direct contact of faeces with produce or indirect contamination of equipment, containers and materials with faeces or through workers touching them and then handling produce.

Practice 61. *Domestic and farm animals are excluded from the production site, particularly for crops grown in or close to the ground, and from areas where produce is harvested, packed and stored*

Domestic animals include those animals that are raised as family pets or as a source of food for the family – for example, dogs, cats, cows, chicken, ducks, birds, sheep, monkeys, mice, and rabbits. Farm animals are those animals raised for commercial purposes – for example, cows, sheep, chickens, pigs, and ducks.

Figure 16. Domestic and farm animals must be excluded from the production site, particularly for crops grown in or close to the ground, and from areas where produce is harvested, packed and stored.

Excretions and body fluids (urine, faeces, saliva), feathers and the skin of these animals can be a source of biological contamination. They should be excluded from production sites, particularly for crops grown in or close to the ground, and from areas where produce is harvested, packed and stored. Workers must be instructed to clean their hands after coming in contact with animals.

Practice 62. *Measures are taken to prevent the presence of pests in and around handling, packing and storage areas.*

The presence of pests in and around areas where produce is handled, packed and stored needs to be minimised. The measures used can be physical barriers or chemical treatments. Examples of control measures are:

- Use baits and traps to control rodents.
- Use blinds or fixtures over openings in walls (doors and windows) to prevent entry of birds.
- Use barriers and other deterrents to prevent birds from roosting above where produce is exposed and where packing containers and materials are stored.
- Regularly dispose of waste from areas where produce is packed, handled and stored.
- Store containers and materials off the ground or floor and keep them dry, ventilated and covered.
- Store containers inverted after cleaning.

Practice 63. *Baits and traps used for pest control are located and maintained to minimise the risk of contaminating the produce and packing containers and materials. The location of baits and traps is recorded.*

Baits and traps used for pest control must be located and maintained to prevent chemicals being spread accidentally or by the pest onto produce, equipment, containers, and materials. Measures such as using chemical blocks instead of pellets, constructing physical barriers on the bait and trap and placing the bait or trap in another container will minimise the risk of the chemicals being spread.

The location of baits and traps must be recorded to show the risk of cross contamination has been minimised. The location can be recorded on a map of the building or structure or described in a log book.

Personal hygiene

Farm workers (family members and employees) can be a source of biological and physical contamination of fresh produce. Biological contamination can occur through direct contact of their hands and clothing with produce and indirectly by contaminating equipment, containers and materials that come in contact with produce. Physical contamination can be caused by careless workers dropping jewellery, clothing, bandages, and gloves into produce or packing containers.

The microorganisms that are spread by workers include the bacteria, *Staphylococcus aureus, Shigella* spp. and *Salmonella* spp. and the viruses, Hepatitis A virus, Norwalk and Norwalk-like viruses, and small round shaped viruses (SRSV's). All have been associated with food poisoning outbreaks where a worker was identified as the likely contamination source.

Poor personal hygiene practices are the primary cause of contamination – either due to a lack of awareness by the workers or a lack of toilet and hand washing facilities. Pathogenic microorgansims can be found all over the body, but especially in and around the bottom, nose, mouth, and open sores. Hands can be contaminated when going to the toilet, blowing the nose or eating. Produce can be contaminated by dirty hands and clothing and also through sneezing, coughing and spitting.

Practice 64. *Workers have appropriate knowledge or are trained in personal hygiene practices and a record of training is kept.*

Workers must be aware of the ways they can contaminate produce and follow appropriate personal hygiene practices. They must complete training if they do not have sufficient knowledge and a record needs to be kept to show that workers have been trained. The training record must include the name of the person and the date of training. This information can be kept in a log book or on a record sheet.

Basic personal hygiene practices are:

- use correct methods for washing and drying hands after visiting the toilet, handling animals, smoking, eating, and handling waste food and rubbish,
- cover cuts and sores to avoid contact with produce,
- do not smoke, eat, or spit when handling produce,
- inform the supervisor if sick, and
- do not wear jewellery.

If gloves are used when handling produce, either use disposable gloves and change them frequently or wash reusable gloves before each use.

Workers with infectious diseases such as Hepatitis A virus can contaminate produce during handling. Signs of infectious disease include diarrhoea, vomiting, coughing, fever, and jaundice. Workers with infectious diseases should not handle produce.

Practice 65. *Written instructions on personal hygiene practices are provided to workers or displayed in prominent locations.*

To reinforce personal hygiene standards, written instructions must be provided to workers or displayed in clearly visible locations. The instructions must be simple and written in a language that the workers can understand. Photographs, diagrams and cartons can convey simple and clear messages.

Practice 66. *Toilets and hand washing facilities are readily available to workers and are maintained in a hygienic condition.*

Adequate toilets and hand washing facilities must be readily available for workers. Basic requirements for hand washing are clean water, soap and a method for drying hands such as disposable paper. Shared towels, rags or cloths should not be used for drying as they can become contaminated and may spread the microorganisms.

Source: Mr. Baharudding Abdul Manap,Department of Agriculture, Malaysia

Figure 17. Toilets and hand washing facilities must be readily available to workers and maintained in a hygienic condition.

Toilets should be constructed and located so that there is no run-off of sewage into the production site or water source. The toilets and hand washing facilities should be cleaned and maintained regularly and replenished with soap and paper towels and a supply of clean water for hand washing.

Practice 67. *Sewage is disposed of in a manner that minimises the risk of direct or indirect contamination of produce.*

Care must be taken when disposing sewage from toilets. Contamination of produce can occur directly from contaminated hands or indirectly through contamination of soil, water, equipment, containers and materials.

Produce treatment

Produce may be treated after harvest for a number of reasons – washing to remove dirt and other residues, applying fungicides to control disease, applying chemicals for pest disinfestation, and applying surface coatings to reduce moisture loss and improve appearance. Chemicals used in these treatments may be a source of contamination to produce and the water used to apply the treatments may be a source of biological contamination.

Practice 68. *The application, storage, and disposal of chemicals used after harvest, including pesticides and waxes, follow the same practices as described in the Chemical section.*

Chemicals used after harvest to treat produce include pesticides such as fungicides, insecticides, and fumigants and surface coatings such as waxes and other products. Use of these chemicals must comply with the requirements of the country where the produce is grown and traded. Guidelines on implementing practices associated with applying, storing and disposing of these chemicals are described in Section 3.5 Chemicals.

Practice 69. *The use of water for handling and treating produce after harvest follows the same practices as described in the Water section.*

Guidelines for the use of water for handling and treating produce after harvest are contained in Section 3.4 Water.

Practice 70. *The final water applied to the edible parts of produce is equivalent in quality to potable water standard.*

The final water applied to produce presents the highest risk of contamination as microorganisms in the water will remain on the produce surface. This last application of water may be for washing or applying pesticides. The quality of this final water must be equivalent to potable water standard. The WHO guidelines stipulate that potable water should have no detectable E.coli in 100 millilitres of water.

Figure 18. The final wash water applied to the edible parts of produce must be equivalent in quality to potable water standard

Storage and transport

Storage and transport conditions can be a source of chemical, biological and physical contamination. Chemical contamination can be caused by spillage of chemicals stored or transported close to produce or equipment, containers and materials that contact produce. Biological contamination can be caused by placing containers in direct contact with soil, dirty storage areas, pallets and vehicles contaminated with faeces and soil and transport of animals with produce. Physical contamination can be caused by foreign objects falling into produce or packing containers.

Practice 71. *Containers filled with produce are not placed in direct contact with soil where there is a significant risk of contaminating produce from soil on the bottom of containers.*

Contamination of produce with pathogenic microorganisms may occur if the soil on the bottom of a container falls onto produce in the container stacked below. The risk of the contamination causing a food safety outbreak is highest for produce that are consumed raw. When stacking containers, the base should be checked for presence of soil and other foreign matter and cleaned as required or the container should not be stacked on top of other containers.

Practice 72. *Pallets are checked before use for cleanliness, chemical spills, foreign objects and pest infestation, and are cleaned, covered with protective material or rejected if there is a significant risk of contaminating produce.*

Practice 73. *Transport vehicles are checked before use for cleanliness, chemical spills, foreign objects, and pest infestation, and cleaned if there is a significant risk of contaminating produce.*

Pallets and transport vehicles can be a source of contamination from chemical and fertiliser spills from previous use, pest infestation, splinters from damaged boards, and dirt and foreign objects. Pallets and vehicles must be checked before use for cleanliness, chemical spills, foreign objects and pest infestation and either cleaned, covered with protective material or rejected if there is a significant risk of contaminating produce.

Practice 74. *Produce is stored and transported separate from goods that are a potential source of chemical, biological and physical contamination.*

Produce must not be stored and transported with goods that are a potential source of chemical, biological and physical contamination – for example, chemicals, fertilisers, soil additives, and domestic and farm animals.

Figure 19. Transport vehicles must be checked before use for cleanliness, chemical spills, foreign objects, and pest infestation, and cleaned if there is a significant risk of contaminating produce.

3.7 Traceability and recall

An effective system for identifying, tracing and recalling produce is needed so that if unsafe produce is detected, it can be removed from sale and the cause of contamination identified and re-occurrence prevented. The essential requirements for an effective system are:

- each production site is identified by a name or code,
- each batch of packed containers is clearly marked with an identification code,
- a record is kept of the batch identification, date of supply, source and destination,
- records of farm operations are kept, and
- procedures for recalling produce and investigating problems are developed.

A batch is defined as all produce harvested and packed on the same day from the same source, which has been treated in the same way.

Practice 75. *Each separate production site is identified by a name or code. The name or code is placed on the site and recorded on a property map. The site name or code is recorded on all documents and records that refer to the site.*

A site is a defined area on the farm. If there is more than one production site on the farm, they must be identified

by a name of code. For example, sites may be identified with names like road block, house block or dam block or with codes like block A, B, C or block 1, 2, 3 and so on.

The whole farm can be treated as one production site. The consequence of not distinguishing separate production sites is that if a food safety complaint occurs, the entire farm must be treated as a potential source of contamination. If the different production sites are identified, the potential source of contamination may be isolated to a particular production site.

The different production sites must be physically identified with a sign showing the site name or code. This can be as simple as a peg with the name or code written on the top of the peg. Placing a sign on the site minimises the risk of workers accidentally applying incorrect treatments.

The location of the site must be identified on a farm plan, with the name or code shown. The site name or code must also be recorded on all documents and records for cross-referencing and to enable trace back of the batch to the potential source of contamination.

Practice 76. *Packed containers are clearly marked with an identification to enable traceability of the produce to the farm or site where the produce is grown.*

Packed containers that are prepared for sale must be marked with an identification to enable trace back to the farm or production site. This includes produce packed on the farm and produce in field containers ready for transport to another establishment for packing.

Simple methods can be used to identify the farm. Examples are attaching a card or label onto the container with the name of the farm or using a particular colour for the container. Markings and labels should be waterproof to prevent deterioration.

If more than one production site is present on a farm, marking the site name or code on the container enables trace back to each individual production site. For example the letter “A” marked on a container would indicate that the produce was harvested from Block A.

Similarly, where produce is harvested a number of times from one production site, traceability is enhanced by marking the date of packing or a code on the container. An example of a packing code is the day number for the month and the year – for example 240906 would refer to the 24th day of September, 2006.

Where produce from more than one farm is packed together in the same container, the name of the farm or a code must be marked on each container to identify the farm. For example, each farm could be allocated a number and the number is then marked on the container.

Figure 20. Where produce from more than one farm is packed in the same brand, marking of field and packed containers with a name or code will enable produce to be traced back to each farm.

Practice 77. *A record is kept of the date of supply, quantity of produce and destination for each consignment of produce.*

The date of the supply of the produce, quantity of produce and the destination where the consignment was sent must be recorded. This information can be recorded in a log book or on a record form. An example of the information to record is as follows:

"30 baskets of tomatoes from Block B were picked and packed on the 20th April 2006 and sold to trader X in Ho Chi Minh City".

Practice 78. *When produce is identified as being contaminated or potentially contaminated, the produce is isolated and distribution prevented or if sold, the buyer is immediately notified.*

When produce is identified as being contaminated or potentially contamination, sale of the produce must be stopped. If the produce is still on the farm, it must be isolated from all other produce and not distributed. For example, the produce could be placed in one area of the packing shed and a brightly coloured ribbon placed around the area with a sign saying "do not remove".

If the produce has been sold, all buyers must be immediately notified and requested to withdraw the consignment from sale. Produce that is contaminated and presents a high risk of causing illness to consumers must be destroyed after being recalled.

Practice 79. *The cause of any contamination is investigated and corrective actions are taken to prevent re-occurrence and a record is kept of the incident and actions taken.*

The cause of any contamination must be investigated and actions taken to correct the problem and prevent re-occurrence. This involves tracing the particular consignment of produce back to the farm or production site and using records to identify possible causes for the contamination. Once the cause has been identified, the problem must be addressed and re-occurrence prevented.

A record of the incident and actions taken must be recorded. This information can be recorded in a log book or on a record form.

3.8 Training

Practice 80. *Employers and workers have appropriate knowledge or are trained in their area of responsibility relevant to good agricultural practice and a record of training is kept.*

People whose roles may impact on food safety must have adequate knowledge and skills to perform their duties. Their training needs should be considered and appropriate training planned and carried out. The training may take the form of on-the-job training or formal training. Refresher training and signs in the work area help to ensure workers are aware of food safety hazards and measures to reduce the risk of hazards occurring.

A record of training must be kept to show that employers and workers have been trained. This information can be recorded in a log book or on a record form. An example of a training record form is contained in Section 5. Examples of documents and records.

3.9 Documents and records

Practice 81. *Records of good agricultural practices are kept for a minimum period of at least two years or for a longer period if required by government legislation or customers.*

Records enable tracing back of consignments to investigate possible causes of food safety problems and also provide evidence for auditors and customers that good agricultural practices have been implemented. They must be kept for a minimum of 2 years of longer if required by government legislation or customers.

Practice 82. *Out of date documents are discarded and only current versions are used.*

To avoid the use of obsolete documents, any out of date documents must be discarded and only current versions used. Placing the date of preparation in the footer of the document will identify the latest version.

3.10 Review of practices

A review of practices is necessary to confirm that practices are being carried out as required and records are

accurate and contain the required information. This self-assessment identifies the practices that are not being done correctly and actions needed to investigate and rectify the problem.

Practice 83. *All practices are reviewed at least once each year to ensure that they are done correctly and actions are taken to correct any deficiencies identified. A record is kept of practices reviewed and corrective actions taken.*

All practices must be reviewed at least once each year. The practices do not have to be reviewed at the same time. It is best to review the practices at the time when they are being undertaken. For example at harvest time, review the practices that are associated with harvesting and preparation of the product for sale. A review of the application of pesticides during production would be undertaken before produce is harvested.

Despite best intentions, problems arise from time to time. The review may identify a practice that is not being done correctly. The problem must be investigated and actions taken to correct the problem and prevent it happening again.

A record must be kept of the practices reviewed and corrective actions taken. A self-assessment checklist is a useful tool. It provides a simple, systematic outline for reviewing practices and when completed it provides a record of the review and corrective actions taken. An example of a self-assessment checklist and corrective action is contained in Section 4. Self-assessment checklist.

Practice 84. *Actions are taken to resolve complaints related to food safety, and a record is kept of the complaint and actions taken.*

Complaints from customers or others concerning food safety must be investigated and actions taken to resolve the complaint. The complaint may be the detection of an excess chemical residue, the presence of a physical hazard or illness resulting from consuming the produce.

A record of the complaint and actions taken must be kept. This information can be recorded in a log book or on a record form.

4. Self-assessment checklist – good agricultural practices

This self-assessment checklist enables the level of compliance with the good agricultural practices contained in the food safety module of ASEAN GAP to be checked. The relevance of the practices will depend on the location of the farm or packing business, type of produce, and the systems used for production, harvesting, handling, packing, storage and transport. Each practice is assessed and a tick is placed in the relevant column. If attention is needed, the actions required are recorded in the column titled, “Actions required/ taken”. When the actions have been taken, the assessor checks that the actions are satisfactory and writes a comment in the “Actions required/ taken” column with the date and a signature.

Site history and management	**Yes**	**Needs attention**	**Not relevant**	**Actions required/ taken**
1. The risk of contaminating produce with chemical and biological hazards from the previous use of the site or from adjoining sites is assessed for each crop grown and a record is kept of any significant risks identified.				
2. Where a significant risk of chemical or biological contamination of produce has been identified, either the site is not used for production of fresh produce or remedial action is taken to manage the risk.				
3. If remedial action is required to manage the risk, the actions are monitored to check that contamination of the produce does not occur and a record is kept of the actions taken and monitoring results.				
4. The location of any contaminated sites on the property, which are unsuitable for production of fresh produce, is recorded.				
Planting material				
5. If planting material is produced on a farm, a record is kept of any chemical treatment used and the reason for use.				
6. If planting material is obtained from another farm or nursery, a record is kept of the name of the supplier and the date of supply.				
7. Varieties known to be toxic for human consumption are not grown.				

Fertilisers and soil additives	Yes	Needs attention	Not relevant	Actions required/ taken
8. The risk of chemical and biological contamination of produce from the use of fertilisers or soil additives is assessed for each crop grown and a record is kept of any significant hazards identified.				
9. If a significant hazard from the use of fertilisers or soil additives is identified, measures are taken to minimise the risk of contamination of produce.				
10. Fertilisers and soil additives are selected to minimise the risk of contamination of produce with heavy metals.				
11. Untreated organic materials are not applied in situations where there is a significant risk of contaminating the produce.				
12. Where an organic material is treated on the farm before application, the method, date and duration of the treatment are recorded.				
13. If a product containing organic materials is obtained from off the farm and there is a significant risk of contaminating the produce, documentation is available from the supplier to show that the material has been treated to minimise the risk of contaminating the produce.				
14. Human sewage is not used for production of fresh produce.				
15. Equipment used to apply fertilisers and soil additives is maintained in working condition and checked for effective operation at least annually by a technically competent person.				
16. Areas or facilities for storage, mixing and loading of fertilisers and soil additives and for composting of organic materials are located, constructed and maintained to minimise the risk of contamination of production sites and water sources.				
17. A record of fertilisers and soil additives obtained is kept, detailing the source, product name, and date and quantity obtained.				
18. The application of fertilisers and soil additives is recorded, detailing the date, name of the product or material used, treatment location, application rate, application method, and operator name.				

Water	Yes	Needs attention	Not relevant	Actions required/ taken
19. The risk of chemical and biological contamination of produce is assessed for water used before harvest for irrigation, fertigation, and applying chemicals, and after harvest for handling, washing, produce treatment, and cleaning and sanitation. A record is kept of any significant hazards identified.				
20. Where water testing is required to assess the risk of contamination, tests are conducted at a frequency appropriate to the conditions impacting on the water supply, and a record of test results is kept.				
21. Where the risk of chemical and biological contamination of produce is significant, either a safe alternative water source is used or the water is treated and monitored and a record is kept of the treatment method and monitoring results.				
22. Untreated sewage water is not used during production and postharvest handling of produce. In countries where the use of treated water is permitted, the water quality must comply with the relevant regulations.				
Agrochemicals				
23. Employers and workers have been trained to a level appropriate to their area of responsibility for chemical use.				
24. If the choice of chemical products is made by advisers, proof of their technical competence is available.				
25. Integrated pest management systems are used where possible to minimise the use of inorganic chemicals.				
26. Chemicals are only obtained from licensed suppliers.				
27. Chemicals and biopesticides used on crops are approved by a competent authority in the country where the crop is grown and intended to be traded, and documentation is available to confirm approval.				
28. Up to date information on chemical MRL standards for the country where produce is intended to be traded, is obtained from a competent authority.				
29. Chemicals are applied according to label directions or a permit issued by a competent authority to prevent residue levels exceeding the MRL in the country where produce is intended to be traded.				

Agrochemicals (continued)	Yes	Needs attention	Not relevant	Actions required/ taken
30. To check that chemicals are applied correctly, produce is tested for chemical residues at a frequency required by customers or a competent authority in the country where produce is intended to be traded. The laboratory used is accredited by a competent authority.				
31. The mixing of more than two chemicals is avoided, unless recommended by a competent authority.				
32. Withholding periods for the interval between chemical application and harvest are observed.				
33. Equipment used to apply chemicals is maintained in working condition and checked for effective operation at least annually by a technically competent person.				
34. Equipment is washed after each use and washing waste is disposed of in a manner that does not present a risk of contaminating the produce.				
35. Surplus application mixes are disposed of in a manner that does not present a risk of contaminating the produce.				
36. Chemicals are stored in a well lit, sound and secure structure, with only authorised people allowed access. The structure is located and constructed to minimise the risk of contaminating produce and equipped with emergency facilities in the event of a chemical spill.				
37. Liquid formulations of chemicals are not stored on shelves above powders.				
38. Chemicals are stored in the original container with a legible label and according to label directions or instructions from a competent authority. If a chemical is transferred to another container, the new container is clearly marked with the brand name, rate of use and withholding period				
39. Empty chemical containers are not re-used and are kept secure until disposal.				
40. Empty chemical containers are disposed of according to relevant country regulations and in a manner that minimises the risk of contaminating produce. Official collection and disposal systems are used where available.				

Agrochemicals (continued)	Yes	Needs attention	Not relevant	Actions required/ taken
41. Obsolete chemicals that are unusable or no longer approved are clearly identified and kept secure until disposal.				
42. Obsolete chemicals are disposed of through official collection systems or in legal off-site areas.				
43. The application of chemicals is recorded for each crop, detailing the chemical used, reason for application, treatment location, date, rate and method of application, withholding period, and operator name.				
44. A record of chemicals obtained is kept, detailing chemical name, supplier of chemical, date and quantity obtained, and expiry or manufacture date.				
45. Where applicable, a record of chemicals held in storage is kept, detailing chemical name, date and quantity obtained and date when completely used or disposed of.				
46. If chemical residues in excess of the MRL are detected in the country where produce is traded, marketing of the produce is ceased, the cause of the contamination is investigated, corrective actions are taken to prevent re-occurrence, and a record is kept of the incident and actions taken.				
Other chemicals				
47. Fuels, oils, and other non-agrochemicals are handled, stored and disposed of in a manner that minimises the risk of contaminating produce.				
Equipment, containers and materials				
48. Equipment, containers and materials that contact produce are made of materials that will not contaminate produce.				
49. Containers used for storage of waste, chemicals, and other dangerous substances are clearly identified and are not used for holding produce.				
50. Equipment and containers are regularly maintained to minimise contamination of produce.				
51. Equipment, containers and materials are stored in areas separated from chemicals, fertilisers and soil additives and measures are taken to minimise contamination from pests.				

Equipment, containers and materials (continued)	Yes	Needs attention	Not relevant	Actions required/ taken
52. Equipment, containers and materials are checked for soundness and cleanliness before use and cleaned, repaired or discarded as required.				
53. Harvested produce is not placed in direct contact with soil or the floor of handling, packing or storage areas.				
Buildings and structures				
54. Buildings and structures used for growing, packing, handling and storage are constructed and maintained to minimise the risk of contaminating produce.				
55. Grease, oil, fuel, and farm machinery are segregated from handling, packing and storage areas to prevent contamination of produce.				
56. Sewage, waste disposal and drainage systems are constructed to minimise the risk of contaminating the production site and water supply.				
57. Lights above areas where produce and packing containers and materials are exposed, are either shatter proof or protected with shatter proof covers. In the event of a light breaking, exposed produce is rejected and equipment and packing containers and materials are cleaned.				
58. Where equipment and tools that may be a source of physical hazards are located in the same building as produce handling, packing and storage areas, the equipment and tools are screened with a physical barrier or are not operated during packing, handling, and storage of produce.				
Cleaning and sanitation				
59. Packing, handling and storage areas and equipment, tools, containers and materials that may be a source of contaminating the produce are identified, and instructions are prepared and followed for cleaning and sanitation.				
60. Appropriate cleaning and sanitation chemicals are selected to minimise the risk of these chemicals causing contamination of produce.				

Animal and pest control	Yes	Needs attention	Not relevant	Actions required/ taken
61. Domestic and farm animals are excluded from the production site, particularly for crops grown in or close to the ground, and from areas where produce is harvested, packed and stored.				
62. Measures are taken to prevent the presence of pests in and around handling, packing and storage areas.				
63. Baits and traps used for pest control are located and maintained to minimise the risk of contaminating the produce and packing containers and materials. The location of baits and traps is recorded.				
Personal hygiene				
64. Workers have appropriate knowledge or are trained in personal hygiene practices and a record of training is kept.				
65. Written instructions on personal hygiene practices are provided to workers or displayed in prominent locations.				
66. Toilets and hand washing facilities are readily available to workers and are maintained in a hygienic condition.				
67. Sewage is disposed of in a manner that minimises the risk of direct or indirect contamination of produce.				
Produce treatment				
68. The application, storage, and disposal of chemicals used after harvest, including pesticides and waxes, follow the same practices as described in the Chemical section.				
69. The use of water for treating produce after harvest follow the same practices as described in the Water section.				
70. The final water applied to the edible parts of produce is equivalent in quality to potable water standard.				
Storage and transport				
71. Containers filled with produce are not placed in direct contact with soil where there is a significant risk of contaminating produce from soil on the bottom of containers.				
72. Pallets are checked before use for cleanliness, chemical spills, foreign objects and pest infestation and are cleaned, covered with protective material or rejected if there is a significant risk of contaminating produce.				

Storage and transport (continued)	Yes	Needs attention	Not relevant	Actions required/ taken
73. Transport vehicles are checked before use for cleanliness, chemical spills, foreign objects, and pest infestation, and cleaned if there is a significant risk of contaminating produce.				
74. Produce is stored and transported separate from goods that are a potential source of chemical, biological and physical contamination.				
Traceability and recall				
75. Each separate production site is identified by a name or code. The name or code is placed on the site and recorded on a property map. The site name or code is recorded on all documents and records that refer to the site.				
76. Packed containers are clearly marked with an identification to enable traceability of the produce to the farm or site where the produce is grown.				
77. A record is kept of the date of supply, quantity of produce and desti nation for each consignment of produce.				
78. When produce is identified as being contaminated or potentially contaminated, the produce is isolated and distribution prevented or if sold, the buyer is immediately notified.				
79. The cause of any contamination is investigated and corrective actions are taken to prevent re-occurrence and a record is kept of the incident and actions taken.				
Training				
80. Employers and workers have appropriate knowledge or are trained in their area of responsibility relevant to good agricultural practice and a record of training is kept.				
Documents and records				
81. Records of good agricultural practices are kept for a minimum period of at least two years or for a longer period if required by government legislation or customers.				
82. Out of date documents are discarded and only current versions are used.				

Review of practices	Yes	Needs attention	Not relevant	Actions required/ taken
83. All practices are reviewed at least once each year to ensure that they are done correctly and actions are taken to correct any deficiencies identified. A record is kept of practices reviewed and corrective actions taken.				
84. Actions are taken to resolve complaints related to food safety, and a record is kept of the complaint and actions taken.				

Name of assessor: **Signature:** **Date:**

5. Examples of documents and record

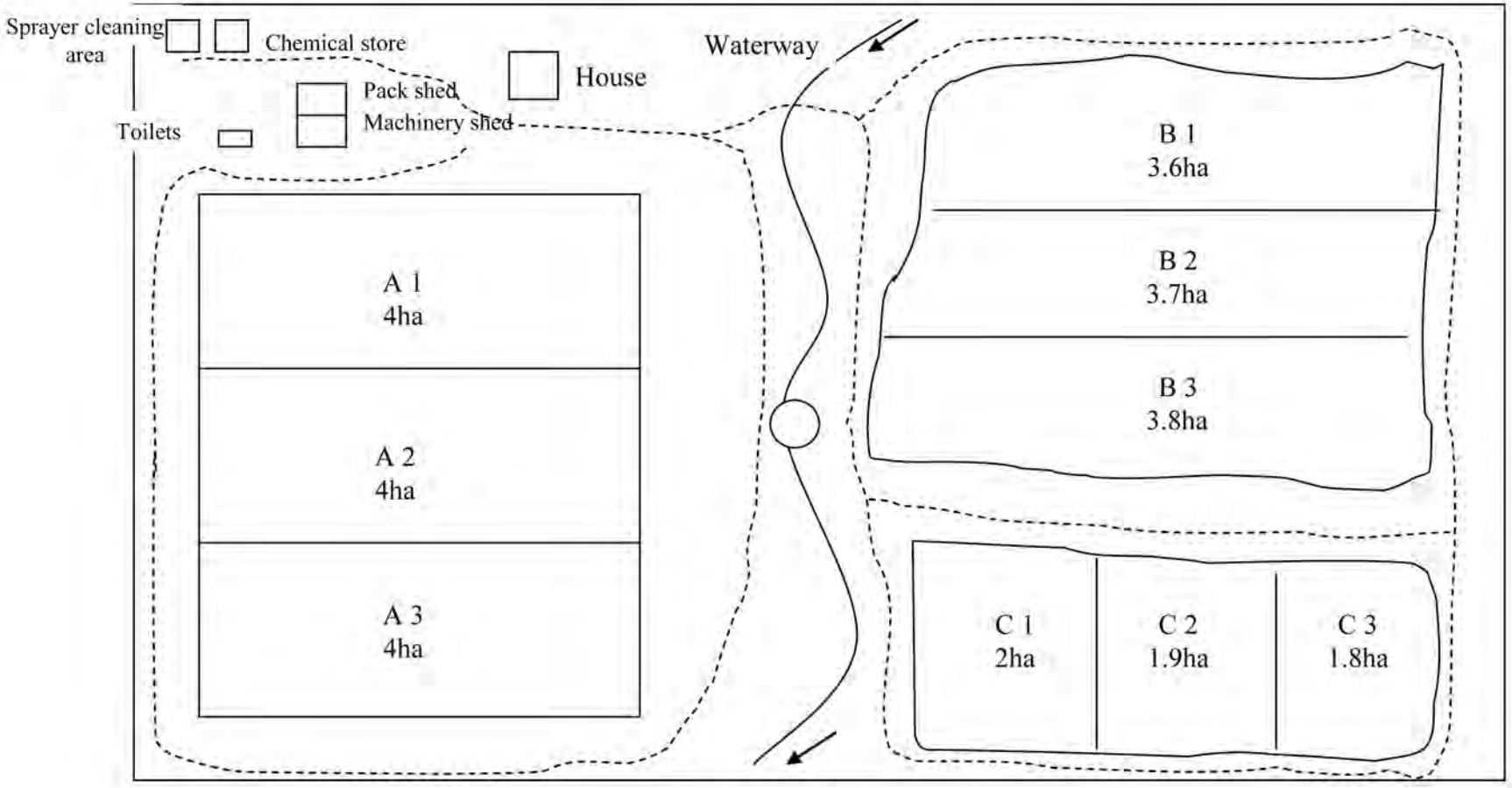
The section contains examples of documents and record forms that are required to implement various practices in the food safety module. The documents and record forms are examples only and other methods and formats can be used. ASEAN GAP specifies the information that has to be documented and the records to keep, but does not specify how to document information and keep records.

The example documents and record forms contained in this section are:

- Farm plan
- Risk assessment record
- Planting material record
- Chemical inventory
- Spray record
- Postharvest chemical record
- Chemical authorisation form
- Fertiliser and soil additives record
- Harvesting and packing record
- Job responsibility and training record
- Cleaning and pest control plan
- Corrective action report
- Personal hygiene instructions

Farm Plan

Farm _____ **Grower** _____



Risk Assessment Record

Business/Grower Name:

Contamination source	Crop	Assessment S = significant; NS = not significant	How is the risk managed?	Signature	Date

Planting Material Record

Business/Grower Name:

Date	**Crop**	**Variety**	**Supplier** (name and address)	**Quantity obtained**	Location where planted

Chemical Inventory

Business/Grower Name:

Date purchased	Name of product	Quantity	Place of purchase	Batch no. (where available)	Manufacture /expiry date	Method and date of disposal

Stocktake	Date: Name:	Date: Name:

Spray Record

Business/Grower Name: **Crop/ Variety:** **Year:**

Date/ Time	Block/ Row	Crop stage/ target	Product	Dilution rate	Application rate	Equipment / method used	Date safe to harvest or WHP	Comments/ weather conditions	Operator

Postharvest Chemical Record

Business/Grower Name:

Chemical	Tank Size	Tank Mixing Rate		Application Method
		Fresh	Top-up	

Date	Time	Chemical	Fresh (F) or Top-up (T)	Comments	Signature

Chemical Authorisation

This chemical storage shed is to be kept locked at all times.

…….. is responsible for the use and storage of all chemicals used on this property, and the training and supervision of all staff who are required to use chemicals.

The following staff have authorisation to use chemicals:

Authorised Person	Manager's Signature	Date

Fertiliser and Soil Additives Record

Business/Grower Name: **Year:**

Date	Crop/ variety	Block Row	Product	Supplier of product	Application rate	Comments	Operator

Harvest and Packing Record

Business/Grower Name:

Crop / Variety	**Planting date**	**Block ID**	**Harvest/ packing date**	**Batch code**	**Amount packed**	**Destination / Consignment No.**	**Comments** (eg. quality, temperature)

Job Responsibility and Training Record

Business/Grower Name:

Name	Chemical application	Fertilising	Irrigation	Harvesting	Grading and packing	Cleaning	Personal hygiene	Repairs and maintain	Self assessment checklist

C = attended farm chemical user course
✓ = performs job and training completed

✓✓ = performs job, training completed and has responsibility for area

Cleaning and Pest Control Plan

Business/Grower Name: **Date:**

Area / equipment cleaned	Frequency	Responsibility	Method

Corrective Action Report

Business/Grower Name:

Date	Problem and cause	Action taken to fix problem	Signature/ date when problem fixed

Personal Hygiene Instructions

All staff:

Wash your hands with soap and water and dry your hands on a single use disposable paper towel before handling fruit

After Visiting the toilet
Handling animals
Smoking
Handling waste food and rubbish

Cover cuts and sores with clean, waterproof dressings.

Inform the manager if you are suffering from gastric illness, hepatitis and other infectious diseases.

Do not smoke, eat food, or spit in produce handling areas.

Signature of employee: **Date:**

Appendix 1. – Glossary of terms

Abbreviations

AADCP	ASEAN-Australia Development Cooperation Program
ASEAN	Association of Southeast Asian Nations
AusAID	Australian Agency for International Development
GAP	Good Agricultural Practice
MRL	Maximum Residue Limit
QA	Quality Assurance
QASAFV	Quality Assurance Systems for ASEAN Fruit and Vegetables

Terms

Biopesticide	A pesticide that is manufactured from biological sources.
Biosolids	Solid, semi-solid or slurry material produced from the treatment of human sewage.
Cleaning	The removal of soil, dirt, grease or other foreign matter.
Competent authority	An organisation or company that is a recognised authority to develop or monitor standards, rules of operation, codes of practice, regulations, and policies. Examples include government departments, international committees such as CODEX, industry organisations, QA/GAP system owners, and auditing companies.
Composting	A managed process where organic materials are subjected to moisture, heat and microorganisms for a specified period to produce a product known as compost.
Contamination	Food safety – the introduction or transfer of a food safety hazard to produce or to the inputs that contact produce, such as soil, water, equipment, and people.
Critical limit	The level of acceptability for a practice or standard. Exceeding the critical limit will result in a practice being unacceptable or high risk of a food safety hazard occurring.
Customer	A business or person who buys or receives produce. For example, a packer, marketing group, distributor, wholesaler, exporter, processor, retailer, or consumer.
Domestic animals	Animals that are raised as family pets or as a source of food for the family– for example dogs, cats, cows, chickens, ducks, birds, sheep, monkeys, mice, rabbits.
Farm animals	Animals that are raised for commercial purposes – for example, cows, sheep, chickens, ducks.
Faeces	The waste from the intestinal tract of animals, – also known as manure.
Fertigation	The application of nutrients through an irrigation system.
Food safety hazard	Any chemical, biological or physical substance or property that can cause fruit and vegetables to become an unacceptable health risk to consumers.
Foreign objects	Unwanted objects in or around produce that may affect food safety or quality – for example, glass, metal, wood, stones, soil, leaves, stems, plastic, and weed seeds.
Fumigation	The applicant of a chemical to control pests in the soil or substrate, such as insects, diseases and weeds.
Good agricultural practice	Practices used to prevent or reduce the risk of hazards occurring during production, harvesting, postharvest handling of produce.

Integrated pest management	A system for managing pests that integrates multiple strategies to minimise the use of chemical pesticides, such as encouraging beneficial insects and microorganisms to flourish, good crop hygiene and plant health, regular monitoring of crops for pests, using biological control agents and soft pesticides, and selective use of chemical pesticides.
Maximum level (ML)	The maximum amount of a heavy metal in fruit and vegetables for sale for human consumption, which is permitted by a competent authority.
Maximum Residue Limit (MRL)	The maximum amount of a chemical in fruit and vegetables for sale for human consumption, which is permitted by a competent authority.
Obsolete chemical	A chemical that is no longer suitable for use. For example approval for use of the chemical may be withdrawn, the chemical is older than the use by date, the container may be damaged and the chemical soiled.
Organic material/ product	A material or commercial product originating from plants and animals and not from synthetic sources.
Persistent chemicals	Organochlorine pesticides, heavy metals and other chemicals that remain for long periods in soil, water and the general environment (for example, herbicides in ground water).
Pest	An unwanted animal or plant that affects the production, quality and safety of fruit and vegetables – for example, insects, diseases, weeds, rodents, birds.
Pesticide	Products used to control pests – for example, insecticides, fungicides, herbicides, fumigants. Pesticides can be manufactured from chemical or biological sources.
Potable water	Water that is suitable for human consumption as approved by WHO or equivalent country regulations.
Produce	Fruit and vegetables (including herbs)
Property	The whole area of a farm or business. It includes all houses, buildings, production areas, roads, fauna and flora, and watercourses within the surveyed boundaries of the property.
Remedial action/ corrective action	Action taken to remove or minimise or prevent re-occurrence of a hazard.
Risk	The chance of something happening that will impact upon a hazard (for example, food safety). It is usually measured in terms of likelihood and consequences.
Sanitise	Reducing the level of microorganisms through using chemicals, heat and other methods.
Side dressing	The application of a fertiliser or soil additive beside a growing plant either on top of or beneath the ground.
Site	A defined area on the property – for example, a production site.
Soil additives	Products or materials that are added to the soil to improve fertility, structure or control weeds. Examples are animal manure, sawdust, compost, seaweed, fish-based products.
Target	The item or site to which an activity is directed. For example, applying a pesticide spray to a target crop to control a target pest or applying fertiliser to a target pad dock for crop nutrition.
Traceability	The ability to follow the movement of produce through the specified stages of production and distribution.
Withholding period	The minimum period permitted between application of a pesticide and harvest of the produce.
Workers	All people working on a farm or in a business, including family members and contractors.

Appendix 2. – References and additional information

Global organisations

- World Trade Organisation of the United Nations - WTO www.wto.org
- World Health Organisation of the United Nations - WHO www.who.int
- Food and Agriculture Organization of the United Nations www.fao.org
- Codex Alimentarius Commission (Codex) www.codexalimentarius.net

Training programs

- Managing farm safety – Farmsafe Australia Inc. – www.farmsafe.org.au

Publications

- Managing farm health and safety – Farmsafe Australia Inc. – www.farmsafe.org.au
- Farm machinery – Guidance notes no. 5 – Australian Centre for Agricultural Health and Safety – www.farmsafe.org.au
- Ergonomics and manual handling on farms – Guidance notes no. 6 – Australian Centre for Agricultural Health and Safety – www.farmsafe.org.au
- Farm chemicals – Guidance notes no. 13 – Australian Centre for Agricultural Health and Safety – www.farmsafe.org.au
- Health and safety in the packing shed, a practical guide – Farmsafe Australia Inc. – www.farmsafe.org.au
- Managing health and safety in the horticulture industries – Hazard checklist – Farmsafe Australia Inc. – www.farmsafe.org.au
- Safety induction information for seasonal workers in horticulture – Farmsafe Australia Inc. – www.farmsafe.org.au
- Safety induction information for contractors in horticulture – Farmsafe Australia Inc. – www.farmsafe.org.au
- Farm injury register form – Farmsafe Australia Inc. – www.farmsafe.org.au

On-farm quality and food safety programs

Program	**Website**
EUREPGAP	www.eurep.org
ChileGAP	www.chilegap.co
Freshcare On-Farm Food Safety Program (Australia)	www.freshcare.com.au
SQF 1000 and 2000	www.sqfi.com
Thailand Q system, Malaysian SALM system, Singapore GAP-VF system, Indonesian INDON GAP system – QASAFV project website	www.aphnet.org