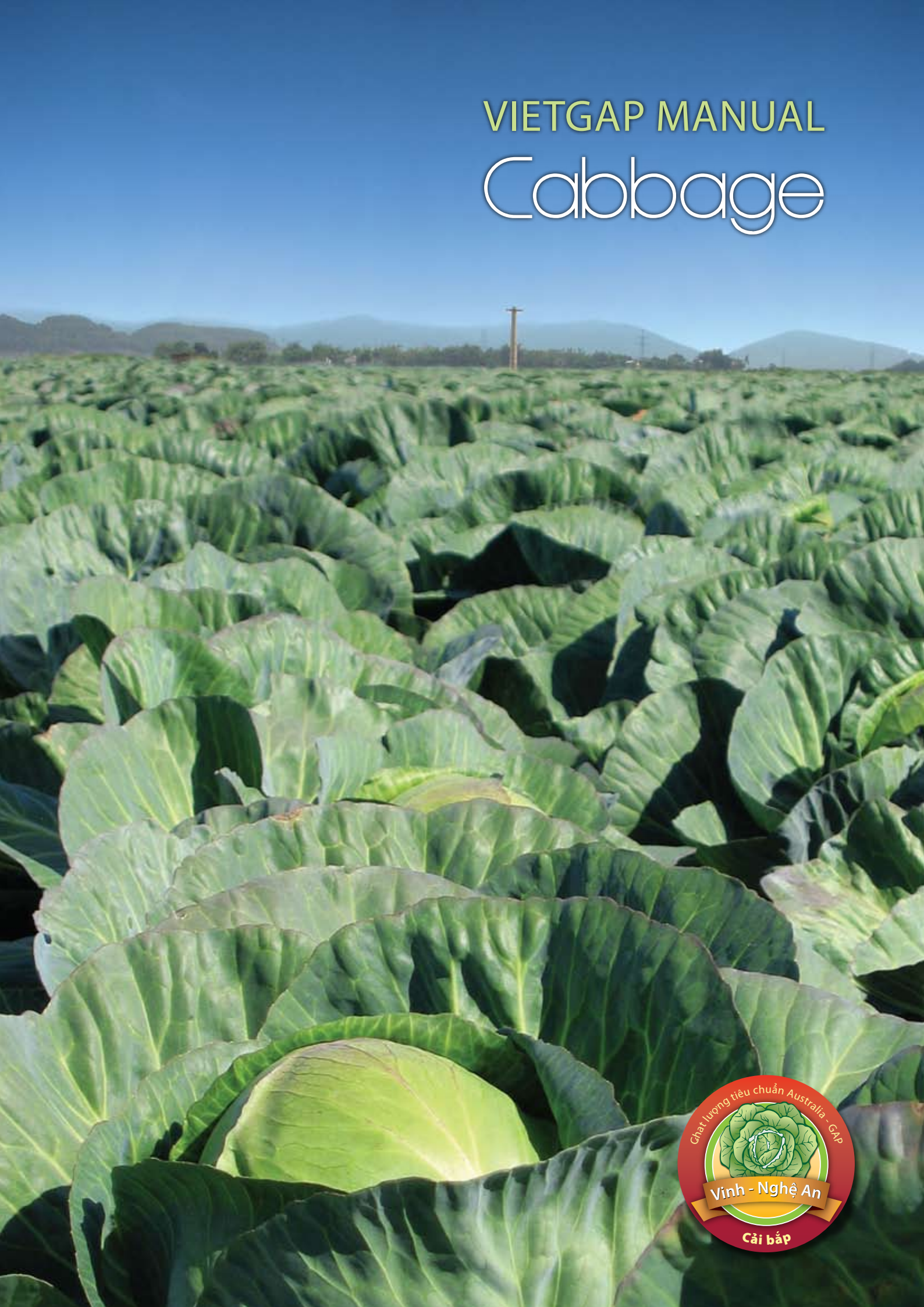
VIETGAP MANUAL

Cabbage



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Contents

Introduction

Eating safe, good quality nutritious fruit and vegetables is the right of every consumer in Vietnam. It is also a minimum requirement of anyone buying fruit or vegetables which have been grown in Vietnam and exported to another country.

VietGAP is based on the principles of ASEAN GAP, EUREPGAP and FreshCare (Australia). It complies with the principles of HACCP and is designed to be achievable by all Vietnamese fresh fruit and vegetable growers but still deliver high quality, safe produce to consumers. It covers four components of fruit and vegetable production: food safety; environmental management; worker health safety and welfare; and product quality.

Whether you are a farmer, collector, wholesaler, retailer, or have any role in the supply of cabbage to the end consumer, you have a moral and legal responsibility to do your best to make sure the food you are supplying is safe. If the crops you deal with were produced and handled according to the principles and guidelines embodied in this cabbage GAP manual, they will fulfil this requirement of VietGAP and be safe for consumers to eat.

How to use the VietGAP Manual: Cabbage

The information is this manual is presented in several parts:

- Cabbage best practice guide
- Farmer's notebook: crop production records
- Guidelines for on-farm food safety
- VietGAP requirements checklist

Cabbage best practice guide: This guide tells you how the crop should be grown to the standards of VietGAP. It contains information about agronomy, pest and disease management, irrigation, harvesting and the specifications of the crop you are supplying.

Farmer's notebook: crop production records: This is a critically important part of the manual. *You must fill out this notebook for every crop you produce.* Make copies of this section, or ask your local MARD representative to do this for you. It is here where you, as a farmer, record the important details about the crop you are producing; details such as which pesticides have been used and at what rate, fertilisers used, and the variety planted.

Guidelines for on-farm food safety: This is designed to give you a broad view of the principles of safe vegetable production. It identifies where contamination is likely to occur and the steps that should be taken to ensure safe food production and handling. You should read this as an overview.

VietGAP requirements checklist: This list has been sourced directly from the VietGAP regulations. *You must comply with the requirements of this checklist to be accredited as a VietGAP producer.* It is essential that you complete this checklist and meet the minimum requirements.

You will also find the following appendices in this GAP manual which contain important information:

- Appendix 1. Impact of insecticides on natural enemies found in brassica vegetables
- Appendix 2. VietGAP: The General Regulation (Resolution No. 379, issued by MARD)
- Appendix 3. List of approved chemicals for use in cabbage production in Vietnam.

Cabbage (Cải bắp)

Best Practice Guide

The purpose of this guide is to assist farmers in growing high quality cabbages which do not contain excessive pesticide residues. Cabbages produced in this way are healthier for consumers to eat, and will be acceptable to higher-value markets such as supermarkets and export.

For farmers to achieve this higher, niche-market price they ***must***:

- Deliver crops on time that meet customers' specifications
- Keep records of the entire production process and keep accurate records of pesticides used (chemical, time applied and rate), under the guidelines of VietGAP
- Follow harvest withholding periods after applying pesticides
- Cabbages must not contain high levels of pesticide residues

Agronomy

Climatic requirements

Seed Germination: Cabbage seed germinates over a wide range of temperatures between 7 and 35°C. The optimum germination temperature is 29°C. Seedlings are susceptible to frost damage and some varieties are susceptible to sunburn if small wrapper leaves are present.

	Soil Temperature °C							
	5	10	15	20	25	30	35	40
Days to germinate	-	15	9	6	4	3	-	-

Crop Growth: The optimum growing temperature for cabbage is a monthly average temperature of between 15 and l8°C. The maximum monthly average should be 24°C and the minimum monthly average should be 4.5°C.

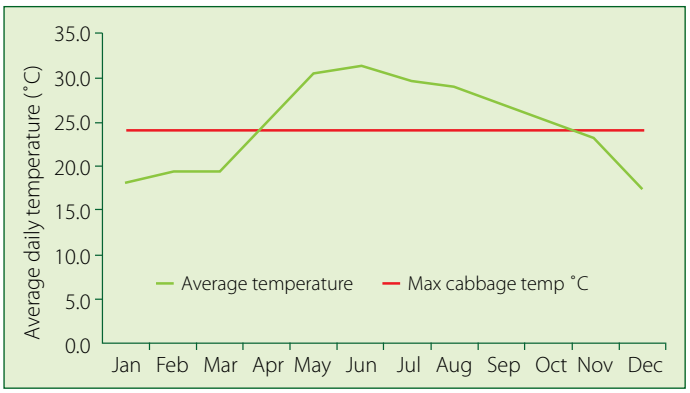

Fig. 1 Average temperature in Vinh City and upper temperature limit for cabbages.

Figure 1 shows that the best times for harvesting cabbages in the central coast region of Vietnam are October to mid April; outside these times quality is likely to be reduced due to hot weather.

Cabbages for sale in Hanoi

Soil requirements

Cabbages can grow on a range of soil types. Generally sandier soils are more suited to early maturing crops in warmer areas and heavier clay soils are better for later crops in cooler areas. The preferred soil pH range is 6 – 6.5 but cabbages can tolerate soils which are alkaline better than soils which are too acid. It is good practice to apply agricultural lime if the soil pH is below 6.0.

High soil organic matter is good and it is a good idea to incorporate organic matter into the soil. This can be done by cultivating in the previous crop residues and adding about 50 kg of compost or 250 kg of rice straw per sow into the soil about 4-6 weeks before planting if possible.

Drainage: Cabbages have a shallow root system and can withstand a relatively high water table up to 30cm below the soil surface. If planting on old rice soil, it is better to plant on mounds to improve soil drainage provided irrigation water can get to the plant roots. This should be checked by digging a small hole near the plants after a watering to be sure the water is being effectively applied.

Salinity: Cabbage has a high degree of salt tolerance but if saline irrigation water is used it should not be applied to the leaves and salt levels should be checked as salt accumulates in the wetted area.

Crop scheduling

Cabbages require about 1000-1050°C heat units (10°C base temperature) from transplanting to maturity. The heat units are calculated by summing the average daily temperature minus the base temperature (10°C) for each day from transplanting to harvest.

Seedling Production

Cell grown seedlings

Seed should be sown into a seedling tray which contains a potting mix. The mix needs to be open and well aerated. Soil is not good enough for seed germination. A good mix contains:

- 100L Canadian peat
- 100L vermiculite
- 800g dolomite
- 800g fine milled superphosphate
- 400g potassium nitrate
- 500g blood and bone
- trace element mix

The trays should be filled with the media, and the seeds sown into small depressions which are made in the media, then covered with vermiculite.

The media should be watered and then placed outside, or under cover provided the light transmission of the covering material is high. Feed the seedlings with a liquid fertiliser as recommended by the manufacturer, usually fortnightly.

Bare rooted seedling

The alternative to growing seedlings in cells is to plant the seed in a nursery area outside and grow them there until the plants are ready to transplant into the growing area.

Planting out and spacing

The plant spacing affects the size of the cabbage head. You should be aiming for a head which weighs between 1 – 1.2 kg. On a 1.4m wide bed (1.8m between centres) you should be aiming for 4 rows, 35cm apart and plants spaced 35cm apart along the rows. This will give a plant population of 66,600 plants per ha (or 3330 plants per 500 m^2 sow).

Planting container-grown seedlings

The seedlings are ready for transplanting in the field when they pull cleanly out of the tray and have developed 4–5 true leaves. The seedlings should not be taller than 10cm and should not be soft or etiolated.

If the seedlings have been grown under cover it is a good idea to put them out into full sun for 2 to 3 days before planting into the field. If the seedlings are too long, it is possible to trim off the tops of the leaves. This reduces transplant shock, but you must be careful not to cut the growing point otherwise the plant will not develop into a normal cabbage head.

To minimise transplant shock:

- Plant in the early morning or late evening. Avoid planting during hot dry winds.
- Make sure there is good contact between the soil and the root ball of the seedling.
- Water immediately or as soon as possible after planting the seedling.

Planting bare-rooted seedlings

Transplanting bare-rooted cabbage seedlings is similar to containerised seedlings except that extra care should be taken to minimise disturbance to the roots. When transplanting the seedlings, aim to minimise the damage to the roots which can lead to bolting or premature seed heads.

Before digging transplants from a seedbed, water them and the soil well about a day before lifting to ensure the plants are full of water (turgid). Keep plants in a shaded place in a bucket of water if not planting out immediately.

Plant the cabbage seedlings by making a hole in the soil, big enough to hold the transplant's roots. Place the transplant in this up to the depth of the true leaves, fill the hole with water several times, and then firm the soil around the plant.

If the seedlings are etiolated and spindly, it is acceptable to trim the tops of the leaves off to reduce water loss. Take care not to cut the growing point.

Irrigation / water management

Cabbages are surface-rooted crops with about 95% of the roots within the top 15cm of the soil. This means that the topsoil must be managed carefully to make sure it has enough water and nutrients to supply the plants adequately.

The maximum growth and yield in cabbage can only be obtained when a plentiful supply of water is available

throughout the plants' growth. Dry conditions, especially during head formation, causes the greatest yield reduction.

Crops can be irrigated either by furrow or sprinkler. It is critical to keep the plants free of water stress but do not over-water. Over-watering means the soil around the roots is saturated, and this is more likely to occur with furrow irritation.

Crop nutrition

The amount of fertiliser that the crop will need depends on the fertility of the soil. The table below provides some guidelines of fertiliser rates that will be required to produce high quality crops in three different soil types.

It is normal to apply a pre-plant fertiliser in a band about 20cm wide along the plant row, and then cultivate this into the top 10–15cm of soil. Then once the plants are established, about 1 month after planting before the heart begins to develop, they should be fertilised again by running fertiliser in bands beside each row of plants and then watering or lightly cultivating this fertiliser into the soil.

Poultry manure is a good source of fertiliser for cabbage crops. One tonne of typical poultry manure would contain: 10–20kg nitrogen, 15–20kg phosphorus and 15–20kg potassium.

Application	Fertile soil (kg/ha)			Average soil (kg/ha)			Infertile soil (kg/ha)		
	N	P	K	N	P	K	N	P	K
Establishment	0-15	0-15	0-15	30	30	30	40	60	70
Side dressing	25-60		0-15	110		50	150		75
Total	**25-75**	**0-15**	**0-30**	**140**	**30**	**80**	**190**	**60**	**145**

The table below has some reference leaf-nutrient levels that can be used to indicate whether the crop has been supplied with adequate fertiliser.

Element	Deficient	Desired	High	Excess
N%	2.5	2.5-4	4	
P%	0.2	0.2-0.5	0.5	
K%	2	2-4	4	
Ca%	1	1-3	3	
Mg%	0.1	0.1-0.6	0.6	
Fe ppm	50	50-200	200	
Mn ppm	10	10-200	200	300
Zn ppm	20	20-100	100	
Cu ppm	5	5-20	20	
Cl%			2	
Na%			1	
B ppm	5-20	20-60	60	100ppm

Pest and disease management

Pest and disease management is a very important area of cabbage production. The main pests will be different for different regions within Vietnam and the Plant Protection Department of MARD will be able to supply up-to-date information on this.

The main pests and diseases are:

Pests:

- Diamond Back Moth (Plutella xylostella)
- Heliothis (Helicoverpa spp.)
- Cutworm or armyworm
- Aphids (various spp.)
- Root knot nematode

Diseases:

- Sclerotinia
- Black Rot

Insect scouting in cabbages

This should commence about 7 days after transplanting. It is a good idea to take a small container with you to collect any larvae or anything that needs to be identified. Also take a 10x hand lens.

1. Take a random walk through the crop and aim to check about 20 plants in a uniform area of crop.
2. Look on the underside of leaves, especially the base of the leaves, along the midrib and into the heart of the plant.
3. Look for and identify: eggs, larvae, parasitised larvae and pupa, and beneficial insects. DBM eggs are very small and difficult to see. You can base DBM assessment on the numbers of larvae.
4. Look for signs of sclerotinia – white-grey cottony growth followed later by sclerotia that look like rat droppings is characteristic of this disease.
5. Make notes on your findings: include the date, insects or diseases found and level of infestation, what controls were used, and rate and date of any pesticide applications.

Pest or Disease	Infestation level assessment	Control Strategy
All Lepidoptera larvae, including, Diamond Back Moth & Heliothis (**not** cutworms)  *Plutella xylostella*	**Insect scouting:** look for eggs and larvae. Begin scouting **not more than** *7 days after transplanting*, and then check each week. **Threshold level for control:** Eggs or larvae found on more than 10% of plants, then consider control.	Use shorter spray intervals during periods of rapid growth. Refer to product labels for specific use rates and recommended spray intervals. **Seedling to approx. 6–8 true leaf stage:** Bt (*Bacillus thuringiensis*) e.g. Dipel® spray if infestation low and as a first defence. Consider use of NVP (nuclear polyhedral virus) in rotation with Bt. Under severe pest pressure, consider using one of the insecticides recommended for use after the 6–8 leaf stage. **6–8 true leaf stage to harvest:** **Preferred Insecticides:** • Spinosad (e.g. Success®) • Emamectin-benzoate (e.g. Proclaim®) • Indoxacarb (e.g. Avatar®) These three insecticides all belong to different mode-of-action groups and should therefore be rotated to help prevent any resistance evolving. They tend to be much more selective and therefore better suited to IPM (Integrated Pest Management) than the older products described below. Resistance to spinosad has been detected in SE Asia in DBM from over-use. **Do not** make more than 2–3 sequential applications of any one of these products before rotating to a different insecticide group. **Alternatives to preferred insecticides:** There is a very large number of generally much cheaper alternative products. These will tend to fall into one of two broad classes of insecticides: • *Synthetic Pyrethroid Products* e.g. permethrin (e.g. Ambush®) or lambda-cyhalothrin (e.g. Karate®) • *Anticholinesterase Products Organophosphates* e.g. chlorpyrifos (eg. Lorsban®) OR • *Carbamates* e.g. thiodicarb (e.g. Larvin®) Great care should be taken when using these older alternative products. Anticholinesterase insecticides in particular can be extremely poisonous and therefore need to be very carefully handled by fully-trained and protected users only. Both anticholinesterase and synthetic pyrethroid products are not particularly selective and tend to kill many beneficial insects as well as the target pest. Resistance in DBM populations to these insecticides is widespread, particularly in the case of the synthetic pyrethroids.
Cutworms *(Agrotis ipsiton)*	Most products are used immediately before or after planting seedlings. **Check product label for recommended timing(s) for use**. If not applied before planting, apply as soon as any losses or cutworm activity is observed.	While this pest is related to other Lepidoptera pests, its method of hiding and feeding protect it from the newer, safer, more selective control options used more effectively on other grubs. This pest hides in the earth during the day and after emerging to feed at night can chew right through seedlings at the base of the stem. And so is there little time for this pest to be exposed to the sprays used to control other Lepidoptera feeding on plant leaves. This means any spray used must be sufficiently active to kill the cutworms after only brief and limited exposure. The current standards are anticholinesterase insecticides, in particular diazinon (e.g. Basudin®). Spray should cover soil out to at least 20cm on both sides of seedling base. The aim is to provide a thin layer of insecticide in the soil that will kill cutworms before or as they emerge to feed on seedling stems.
Aphids *(various spp.)*	**Pre-planting:** During periods of high pest pressure in existing crops	Apply Imidacloprid (e.g. Sherpa®) or other registered neonicotinoid class insecticide directly into seedling cell immediately prior to planting, or as a directed drench in 50–100 mL of water under plants when planting in the field. As this product is highly systemic, under-plant drenching will result in much greater safety to a wide range of beneficial insects than post-emergent foliar sprays.
	Post-planting: Consider spraying if aphids, particularly wingless (apterous) types, are found on more than 10% of plants. Apply once and inspect the result after about 5–7 days. Only reapply if pest pressure warrants and according to label recommendations.	• Imidacloprid (e.g. Sherpa®) • Pymetrozine (e.g. Chess®) • Pirimicarb (e.g. Pirimor®) These products are all from different mode-of-action groupings and so can be rotated during periods of sustained pest pressure to reduce the risk of resistance. Pirimicarb is an anticholinesterase insecticide but is considered much more selective than most other chemicals in this class. Pymetrozine is extremely selective, only affecting aphids and whitefly, but requires good coverage and careful monitoring for effective use. Imidacloprid is the least selective (though still more selective than many older broad-spectrum insecticides) but effective and relatively easy to handle. As with grub sprays, a variety of older products from both the anticholinesterase and synthetic-pyrethroid groups are still used for aphid control. However, their use should be avoided in preference to the three insecticides already mentioned, which are more compatible with IPM.

Pest or Disease	Infestation level assessment	Control Strategy
Root Knot Nematode *(Meloidogyne spp.)* **and other nematodes**	Most nematodes are too small to be seen with the eye. A combined soil and root sample from suspected affected areas examined microscopically in a plant pathology laboratory is the only way to confirm the presence of nematodes.	The best strategy is to adopt hygiene measures to avoid or minimise nematode populations building up in the soil. However, this is not particularly easy, especially in areas with an existing history of infection. Root Knot and many other nematode species often have a broad host range, so crop rotations are not always particularly effective. Many weed species are also suitable hosts for nematodes. Nematode eggs can also persist for a year or more in the soil without a host. Appropriate sanitation and cultural methods that may help to reduce nematode populations include: • Remove and burn crop roots at harvest. • Cultivate land to expose the root zone to sun and heat during the dry season, allowing it to dry out as much as possible. • Ensure no weeds grow during or between crop cycles, removing the food source. • Use resistant varieties if available. Chemical control options (nematicides) tend to involve some very dangerous anticholinesterase products which are not suitable for use in communal village gardens.
Black Rot *(Xanthomonas campestris)*	Any sign of this disease should be treated seriously. Any affected plants should be removed and destroyed without contaminating other plants in the crop. The disease is most serious under sustained wet conditions.	The only effective options for this disease involve cultural or hygiene measures. As the disease is bacterial, fungicides (other than copper) offer no protection. Suggested sanitation methods that may help to reduce disease: • **Do not** replant areas with a known history of this disease. • **Do not** move tools around inside affected areas or from infected to uninfected areas. • Ensure site is well drained and that any run-off water does not enter nearby crops. • Any techniques that might be practically employed to reduce periods of leaf wetness (e.g. sheltered cropping). • **Do not** allow workers to move around inside crops while leaves are wet. • Resistant varieties are not yet available. • Use disease-free seed or seedlings. In the USA, seed-borne disease has been reduced by soaking seed for 25 minutes in water held at 50°C. • Rotate with non-brassica crops. Several foliar applications of copper hydroxide (e.g. Kocide® Blue Xtra) every 10–14 days may help prevent or reduce disease severity.
Sclerotinia white mold *(Sclerotinia sclerotiorum)*	Wet, cooler conditions and poor air circulation favour disease development, although temperature is less important than other factors.	Fungicides are not particularly effective against this disease. Iprodione is registered in some countries for control of white mold but cultural practices are again generally considered the most effective method of control. Suggested sanitation methods that may help to reduce disease: • Avoid planting in areas with poor air circulation, e.g. areas surrounded by windbreaks or other tall & dense crops. • **Do not** plant sequential brassica crops. Plant a break crop not susceptible to sclerotinia in between brassica crops. • Remove weeds also susceptible to sclerotinia. • Avoid bruising and other physical damage to plants as wounding may produce a concentration of nutrients that helps initiate infection sites in the crop.

Maximum allowable pesticide residues, heavy metals and harmful organism levels for cabbage

Standard industry 10TCN 442-2001

Amounts of heavy metals allowed* in vegetables

No	Elements	mg / kg of fresh vegetables (ppm)
1	Arsenic (As)	1
2	Lead (Pb)	2
3	Bronze (Cu)	30
4	Tin (Sn)	40
5	Zinc (Zn)	40
6	Mercury (Hg)	0.05
7	Cadimi (Cd)	1
8	Antimon (Sb)	1

Limit of harmful microorganisms in fresh cabbage **

Food group	Harmful microorganism	CFU/g **
Fresh vegetables (or frozen)	*Coliforms*	200
	Escherichia coli	10
	Salmonella (not in 25g of vegetable)	0

* As stipulated in Decision No. 867/1998/QD-BYT by the Ministry of Health on 4/04/1998 on promulgating the list of hygiene standards for food.

** GAP-limited by the good agricultural practice.


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Dưa Hoàng Kim
LOẠI
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Harvest and postharvest management

Harvesting

The heads should be harvested early in the morning while the weather is cool. Walk through the crop and cut heads which weigh about 1 – 1.2 kg. Leave the wrapper leaves on the heads to protect them during transport.

The heads should be firm, compact and not discoloured or rotten. The stem should be cut directly below the lowest leaf. The harvested heads should be intact, no damage, free of cracks, mould, adhering soil and insects.

As soon as the cabbage heads are harvested they should be taken out of the field and stored in a cool, shaded location.

Do not leave cut heads out in the field in the sun.

Leaving them in the field, especially if it is hot will damage them and reduce the quality of the heads when they reach the customer.

Postharvest, packaging and transport

The ideal temperature for keeping cabbage in good condition is between 0° – 2°C. This will not be possible in Vietnam at the moment but ***the cooler the better***, down to 0°C. This is very important, and anything that can be done to keep the harvested heads cool from harvest until they are delivered to the customer will help maintain the cabbage quality and result in a better price paid to the farmer.

Some techniques that could be used to keep cabbage cool and in good condition are:

- Pack in baskets and keep wrapper leaves on to prevent damage.
- Transport under cover as soon as possible after harvest (ideally no more than 4 hours) to reduce dehydration.
- Provide good ventilation (not overloaded) and protection from physical damage.
- Keep storage areas free of ethylene (ripening hormone) to prevent yellowing. This means not storing the cabbages next to ripening fruit and providing good ventilation in the store.

Quality assurance and traceability

The following is a summary of the key points needed to provide quality assurance and traceability regarding the cabbage crop. These points are a summary of the *FreshCare Manual*.

Keeping records is essential.

The issues to monitor include:

1. Farm management

- You must train your staff regarding the requirements, responsibilities and the operations important to ensure the quality of the product. Also, you (or another person) must verify that the records are being kept.
- Maintain records of all activities and their outcomes as outlined in the sections below.

2. Chemicals

- You must try to minimise the risk of the cabbage being contaminated with persistent chemicals.
- Only legally obtained and properly labelled farm chemicals may be used on your property.
- Establish a secure farm chemical storage area. Store all farm chemicals according to the directions on the container label. Establish an Inventory of chemicals on farm (e.g. name, quantity, date received, date of expiry or manufacture). Check periodically the expiry dates and dispose of chemicals if out of date.
- Staff involved in the use of chemicals must be appropriately trained in chemical safety and the correct use of the products. You must read the label before use. The equipment should be calibrated at least annually and this must be recorded. Records should be kept of applications, for example: date of treatment, weather conditions, chemical and equipment used, and name of the person applying the product.
- Produce must be tested for chemical residues to verify that chemicals are applied correctly and the maximum residue levels are not exceeded.

3. Fresh produce management

- Produce should be prepared, checked and handled according to the customer's product specifications.
- You must identify each product so it can be traced back to its source and/or destination. The farmer must record: the location of separate growing areas on a map; the supplier (especially in the case where the product is sent for packing to another place); harvest date; destination; packing date or a batch identification code; and whether the product has been contaminated or is potentially contaminated.
- The use of fertilisers and soil additives (e.g. animal manures and sawdust) must be managed to minimise the risk of chemical, microbial and physical contamination. They should be stored, applied and disposed of correctly. For fertiliser applications you must record the supplier, type of product, the application date, rate and method of application, description of the treated area and name of the person applying the product.
- The use of water during growing, harvesting, packaging and storage must be assessed for risk of chemical and microbial contamination of produce. If the risk is significant, as shown by water test, a safe alternative water source should be used or the water must be treated to minimise contamination. You need to monitor water quality and record results.
- Equipment, containers and material that come into contact with produce must be designed, constructed and maintained to minimise risk of chemical, microbial and physical contamination of produce.
- You must write a plan for how to manage the working areas, for example what areas are to be cleaned and the method and frequency of cleaning. You must do the same for vermin control.
- Measures must be taken to prevent birds and domestic animals in all areas where produce is grown, packed, handled and stored. Any chemical deterrents used must be appropriate for use in a food-handling area. The location of baits and traps must be recorded and be located and contained to minimise risk of contaminating the product.
- Personal hygiene standards must be followed to minimise the risk of microbial and physical contamination of produce from staff (including family members) and contractors who come into direct or indirect contact with produce. Toilets and washing facilities must be: appropriately designed, readily accessible, adequately equipped and maintained under sanitary conditions. It is important to give verbal, written or display-sign instructions about personal hygiene practices to staff and contractors.
- Produce should not be stored with other goods or under conditions that are a potential source of contamination, you must check the pallets and transport vehicles before use and avoid dripping water from cooling systems during storage and ripening.

Specifications for high quality cabbage

The specifications below are an example of those used by a supermarket in Australia for cabbage. Major suppliers will probably have their own specifications, which should be used in preference to this example.

PRODUCT: **CABBAGE WHOLE**
VARIETY: **Various**
GRADE:

GENERAL APPEARANCE CRITERIA	
COLOUR	*Light green to white leaves depending on variety.*
VISUAL APPEARANCE	*Cabbage should be round, and the head should be tight. Some outer green leaves should be left on to protect the heads in transport. The consignment should be free from foreign matter.*
SENSORY	*Crisp, juicy leaves; slightly sweet flavour, free from foreign and 'off' smells or tastes.*
SHAPE	*Round to oval head*
SIZE	*Heads 1.2 kg or more*
MATURITY	*Heavy for size; no open or very white hearts. Nil with excessive 'woody' core growth or bolting.*
MAJOR DEFECTS	
INSECTS	*With evidence of live insects*
DISEASES	*With evidence of fungal or bacterial rots*
	With evidence of discolouration or disfigurement due to viruses
	With evidence of pest droppings (eg birds and snails)
	With discoloured, water soaked areas (freezer damage)
PHYSIOLOGICAL DISORDER	*With yellow outer leaves (age, ethylene exposure)*
	With tip browning of inner leaves.
MINOR DEFECTS	
PHYSICAL / PEST DAMAGE	*With superficial bruising > 2 sq cm in inner leaves*
SKIN MARKS / BLEMISHES	*With healed scars > 2 sq cm*
PHYSIOLOGICAL DISORDER	*With slight tip browning of outer leaves > 2mm*
CONSIGNMENT CRITERIA	
TOLERANCE PER CONSIGNMENT	*Total minor defects (within allowance limit) to be < 2 defects per item. Total minor defects (outside allowance limit) must not exceed 10% of consignment. Total major defects must not exceed 2 % of consignment. Combined total not to exceed 10%.*
PACKAGING & LABELLING	*Label to identify grower (name and address) and collector (if appropriate), name of the product, grade, date of packing.*
CHEMICAL & CONTAMINANT RESIDUES	*All chemicals used pre/postharvest must be registered and approved for use in accordance with the requirements of VietGAP.*

Extracted from: Woolworths Ltd cabbage specification 2009.

Guidelines
for on-farm food safety: an overview

Scope of the guidelines

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

Hazard

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

Fresh produce production

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

Guideline sections

1. Food safety hazards associated with fresh produce

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

2. Process steps and inputs

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

3. Assessing the risk of contamination

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

1. Food safety hazards associated with fresh produce

It is important to identify and assess all possible food safety hazards on-farm. The hazards can be broadly divided into three categories: *microbiological, chemical,* and *physical*.

The following table lists the potential hazards for each category and possible causes of contamination.

Contamination of produce can occur directly through agricultural practices, or indirectly through produce contacting contaminated surfaces or substances.

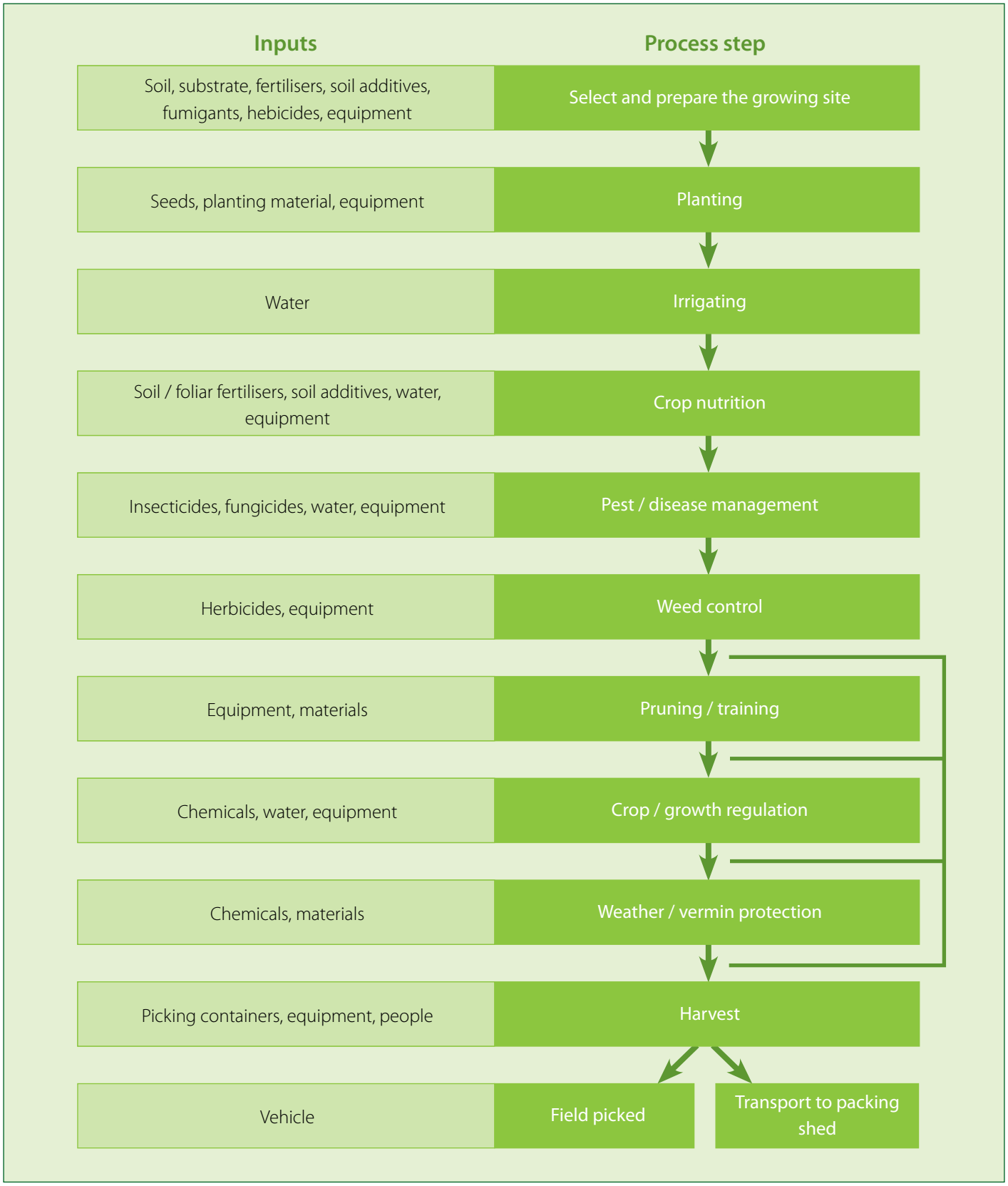
Type of hazard	Hazard	Cause of contamination
Microbiological **Note:** There are many microorganisms in the environment – some are totally harmless, some are beneficial, such as those used in yoghurt and cheese-making, and others are the cause of food spoilage and rotten fruit and vegetables. Only a very small number of microorganisms are harmful to humans. These are called *human pathogenic microorganisms* and are the causes of human disease. Examples include species of bacteria, such as *Salmonella* and *Listeria* and viruses, such as Hepatitis A.	Micro organisms (microbes) on produce in population numbers that may cause food-borne illness in susceptible consumers: • bacteria • viruses • parasites • algae • fungi	• Faeces from or the remains of wild and domestic animals and human sewage contaminating water used for irrigating, pesticide application, harvesting, unloading washing, top icing, hydro-cooling, cleaning. • Untreated organic animal products used for fertilising and soil improvement contacting produce directly or indirectly via the soil. • Picking produce that contacts or drops onto contaminated soil. • Inadequate cleaning of picking containers and harvesting, grading and packing equipment contaminated by soil, decaying matter and faeces of rodents, birds and insects. • Stacking of pallets, crates and bins contaminated with soil and faeces on top of exposed produce. • Packaging and packing material contaminated with faeces from rodents, birds and insects. • Handling of produce by infectious workers due to inadequate toilet and hand-washing facilities, poor personal hygiene practices, and sickness (e.g. communicable diseases such as hepatitis A). • Leakage of contaminated water from recirculating cooling systems in cold rooms.
Chemical	Pesticide residues in produce exceeding maximum residue limits (MRLs) **Note:** pesticides that are not registered or approved for use on specific produce (with permits) have a zero MRL.	• Not reading/understanding the pesticide label. • Incorrect advice. • Incorrect mixing – concentration higher than label rate. • Withholding period not observed. • Equipment incorrectly or not calibrated. • Spray drift from adjacent crop. • Pesticide in soil from previous use. • Pesticide residue in picking bins, crates. • Equipment not cleaned after use. • Multi-purpose use of equipment – for example, both washing and spraying. • Dumping, accidental spillage or seepage of pesticide into soil or water source.
	Heavy metal residues in produce exceeding maximum levels (MLs)	• Continued use of fertilisers with high levels of heavy metals. • High levels of heavy metals present in the soil, naturally or due to previous use. • Development of soil conditions conducive to uptake of heavy metals by crops e.g. acidity, salinity, zinc deficiency.
	Natural toxins	• Unsuitable storage conditions – for example, storage of potatoes in light. • Peanuts, tree nuts and all their products.
	Non-pesticide chemical contamination	• Chemical and fertiliser spills on pallets. • Leakage of chemicals and fertilisers transported with produce. • Oil leaks and grease on equipment in contact with produce. • Spillage of chemicals (e.g. vermin-control chemicals) near produce or packaging materials. • Use of inappropriate cleaning chemicals. • Residues in picking containers used to store chemicals, fertiliser, oil etc.
	Allergenic agents – traces of a substance which may cause a severe reaction in susceptible consumers (e.g. asthmatics, immune-repressed)	• Sulphur dioxide (e.g. desiccation pads used on grapes).

Type of hazard	Hazard	Cause of contamination
Physical	Foreign objects from the environment (e.g. soil, stones, sticks, weed seeds)	• Harvesting of ground crops during wet weather. • Dirty harvesting and packing equipment. • Dirty picking containers and packing materials. • Stacking of dirty pallets, crates and bins on top of exposed produce.
	Glass	• Broken lights above packing equipment and areas where produce is exposed. • Broken bottles picked up by harvesting equipment – left by workers or thrown into plot from passing traffic.
	Foreign objects from equipment and containers (e.g. wood splinters, metal shavings, plastic objects, paint flakes)	• Damaged picking containers, harvesting and packing equipment and pallets. • Inadequate cleaning after repairs and maintenance. • Workshop areas too close to packing and storage areas.
	Foreign objects from human handling (e.g. jewellery, adhesive dressings, gloves)	• Careless or untrained staff. • Inappropriate clothing.

2. Process steps and inputs

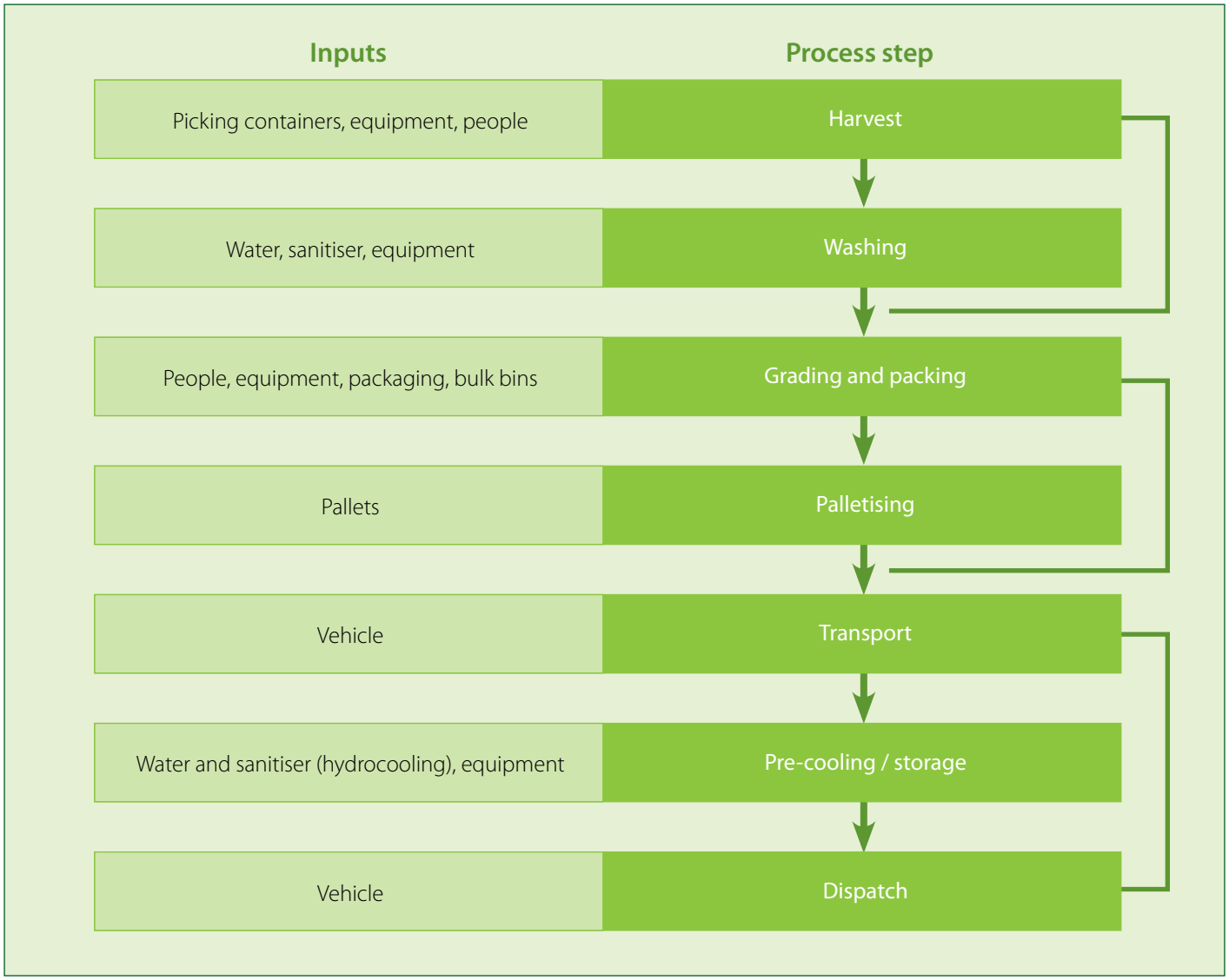
Growing the crop – process flow

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



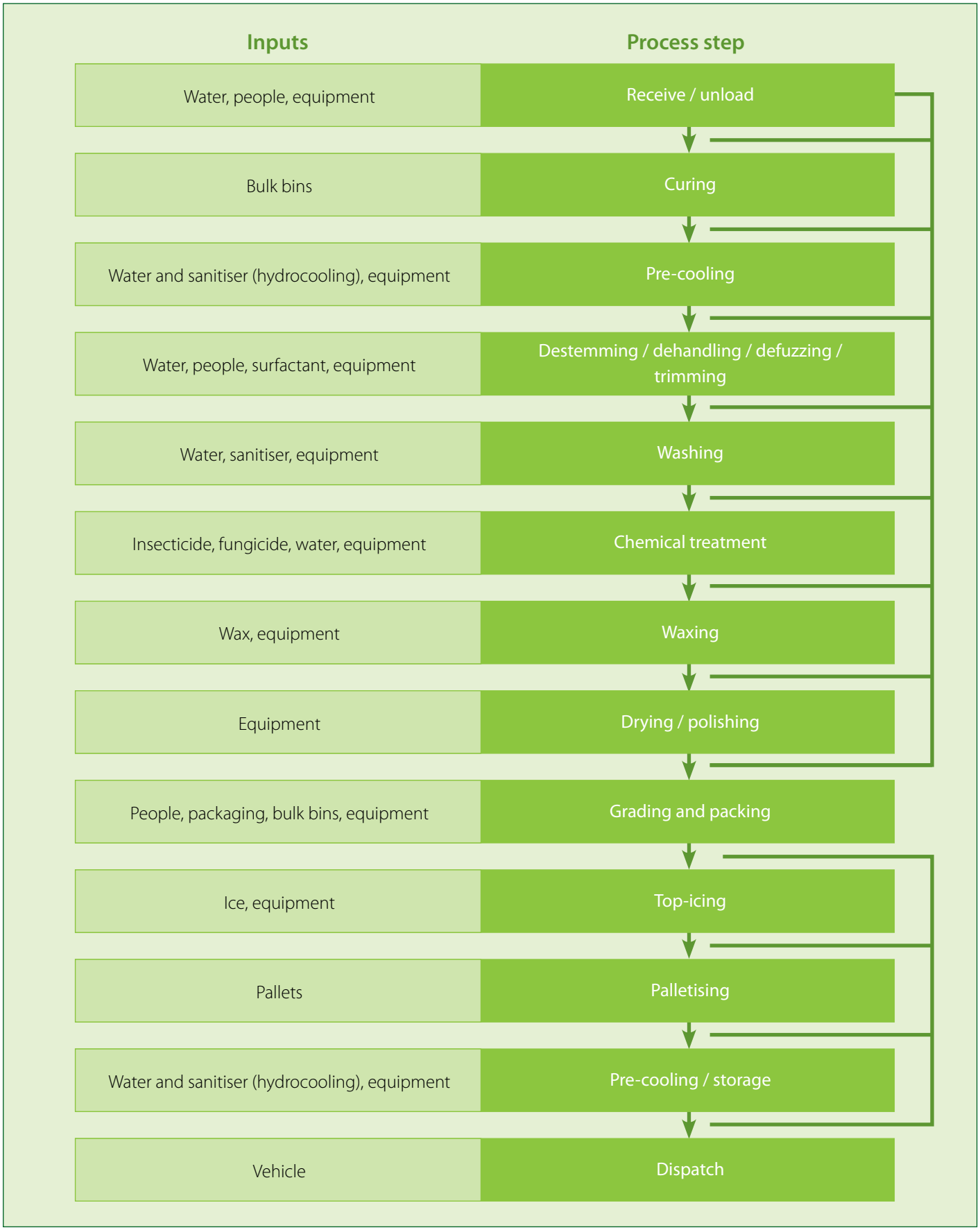
Field packing – process flow

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



Shed packing – process flow

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



3. Assessing the risk of contamination

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

Good agricultural practices help to prevent, reduce or eliminate the occurrence of hazards to ensure that fresh produce is fit for consumption.

3.1 Contamination from chemicals

Persistent chemicals in the soil

One important issue to review is the possible contamination by chemicals that have been used in the past and remain in the soil. *Persistent* chemicals belonging to the organochlorine (OC) and organophosphate (OP) groups may be present on farms due to past use, dumping or spillage. How long chemicals remain in the soil will depend on soil type, climatic conditions and how the chemicals were used.

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

Maximum residue limits

The maximum residue limit (MRL) is the *maximum concentration of a residue that is legally permitted* on produce after harvest.

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

Extraneous residue limits

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

Exceeding the legal limits

Residues detected exceeding the MRL are unacceptable, but do not necessarily represent a hazard to consumers because of the high safety margins used to set the standards. Where an MRL or ERL does not exist, *no residues are permitted in the produce*.

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

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

Allergenic agents

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

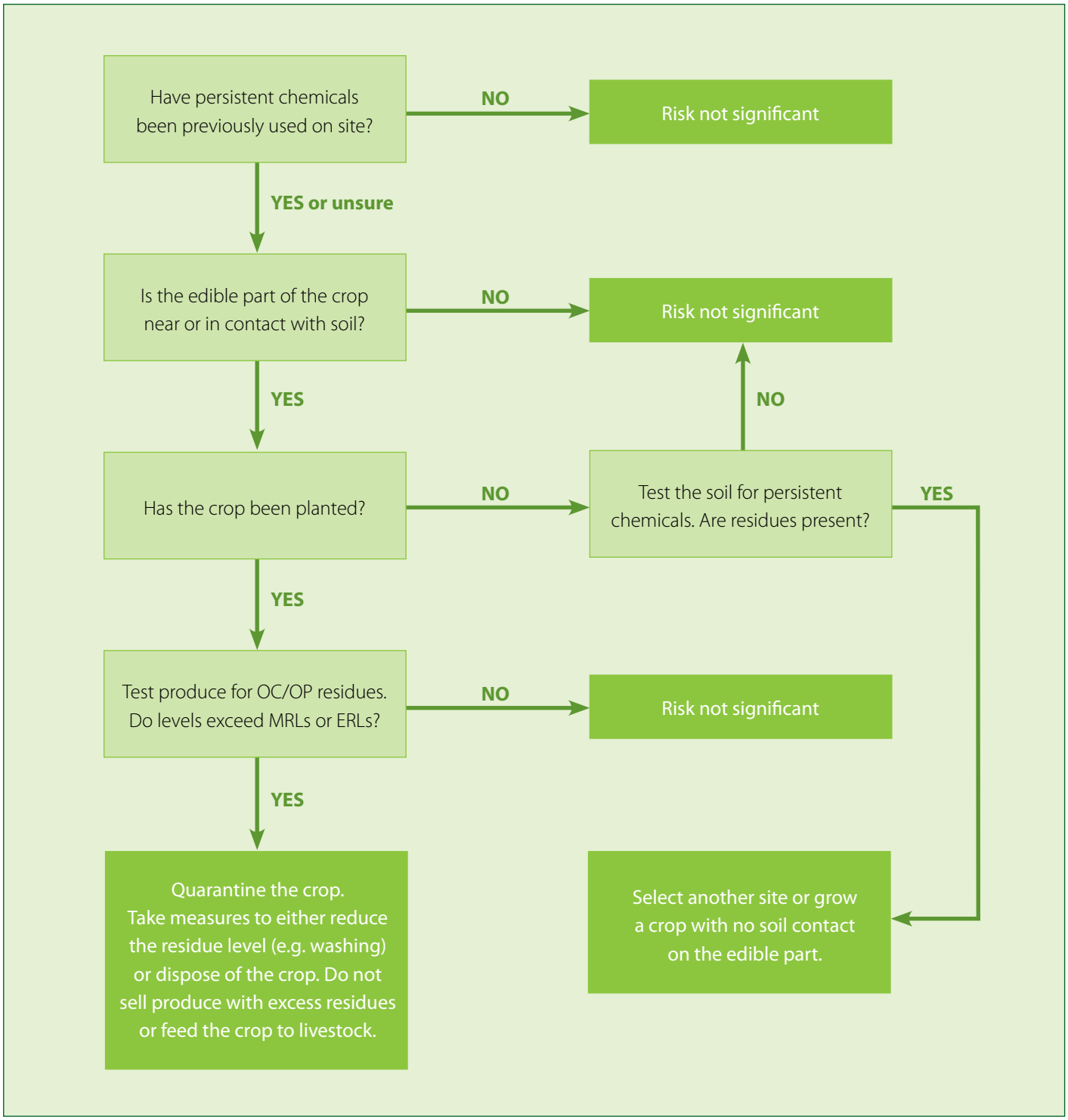
Naturally occurring toxins

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

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

Aflatoxins are the first mycotoxins covered by legislation. The most effective means of controlling aflatoxins in commodities is to prevent the plants from becoming infected with aflatoxigenic strains of fungi.

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



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

3.2 Contamination by heavy metals

Examples of heavy metals are cadmium, lead and mercury. Heavy metals may occur naturally in soils or they can be introduced in small amounts through the use of fertilisers (especially phosphate) and soil additives (such as gypsum and animal manure), and from industrial uses (either past or present).

Cadmium is the heavy metal of most concern to fresh produce. Lead is unlikely to pose a food safety risk, because it is highly immobile in soils, with very little taken up by plants.

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

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

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

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

3.3 Contamination from fertilisers and soil additives

Chemical contamination

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

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

Microbiological contamination

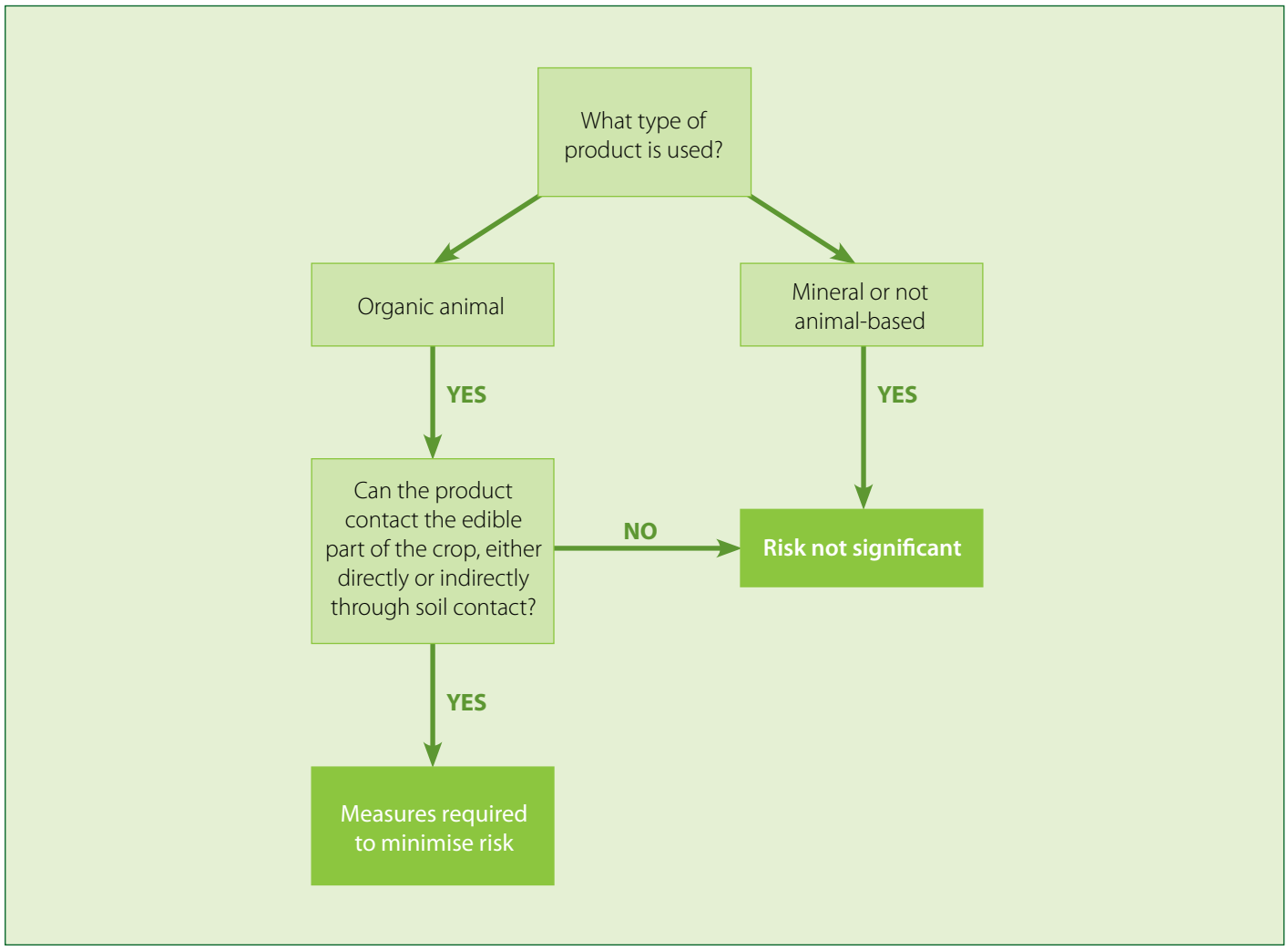
Microbiological contamination of fresh produce can be caused by the use of organic animal products as a fertiliser. Food poisoning microbes present in the guts of animals may transfer into the manure, and then on to fresh produce, thus causing a food safety hazard to humans.

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

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

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

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



3.4 Contamination from water

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

Source of water

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

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

The risk of microbiological contamination is higher if the water is applied to the edible parts of produce immediately before harvest or during packing. This may include overhead irrigation applied just before harvest, wash water, water in post-harvest chemical dips/sprays, water in unloading tanks and troughs, in hydro-coolers and water used for top-icing of packages.

Use of water

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

Type of produce

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

Testing water

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

The following provides a guideline for thermotolerant coliform loads for various water uses:

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

Treating water

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

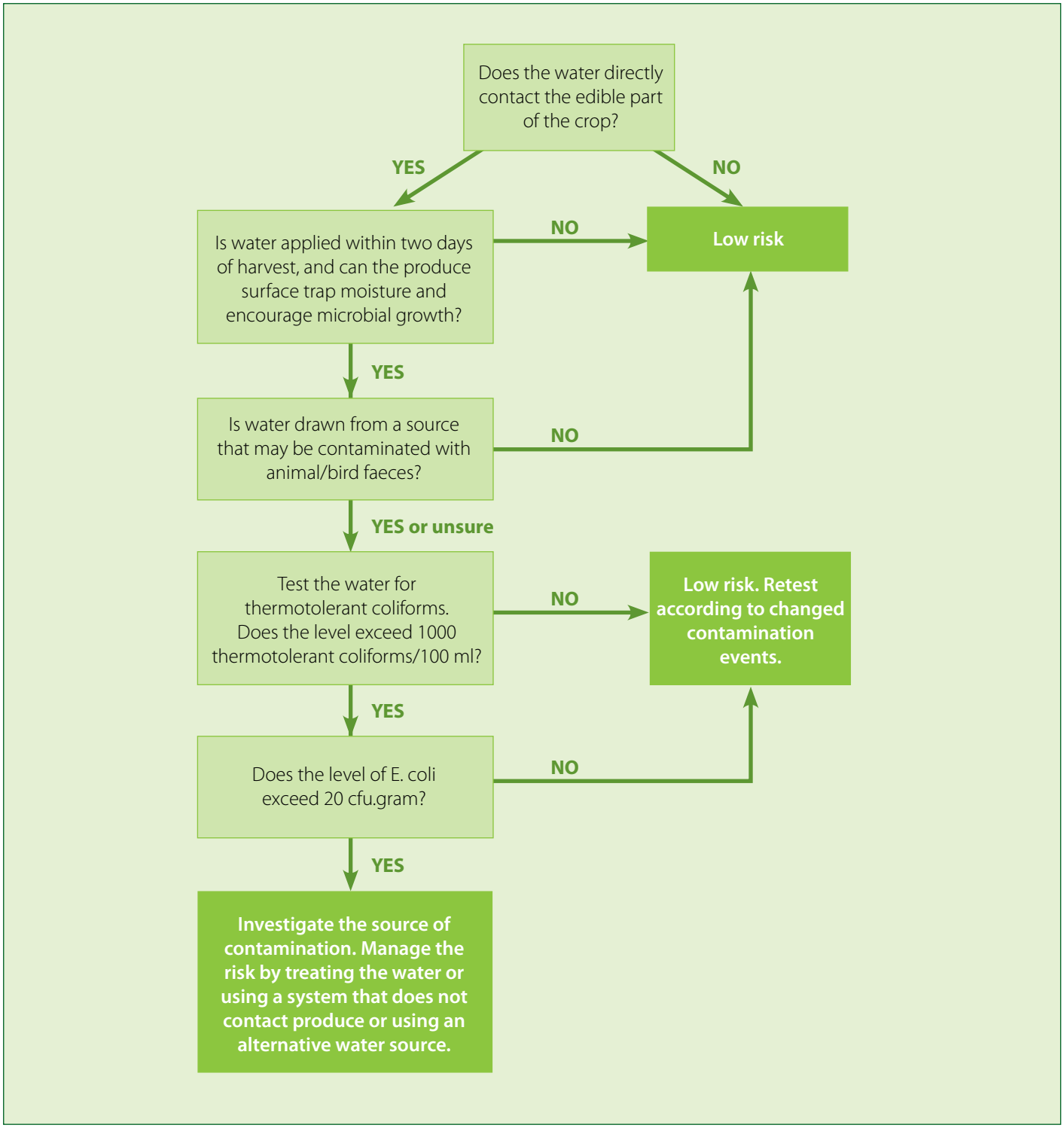
It is important to carefully review the best water treatment for the operation, based on sound technical advice, and following the manufacturer's guidelines. Treatment of water with a sanitiser should be monitored to ensure that it achieves the desired level of microorganism control. A record should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

Decision guides for assessing the risk of microbiological contamination from water

a) Water used for crop spraying

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

b) Water used for irrigation



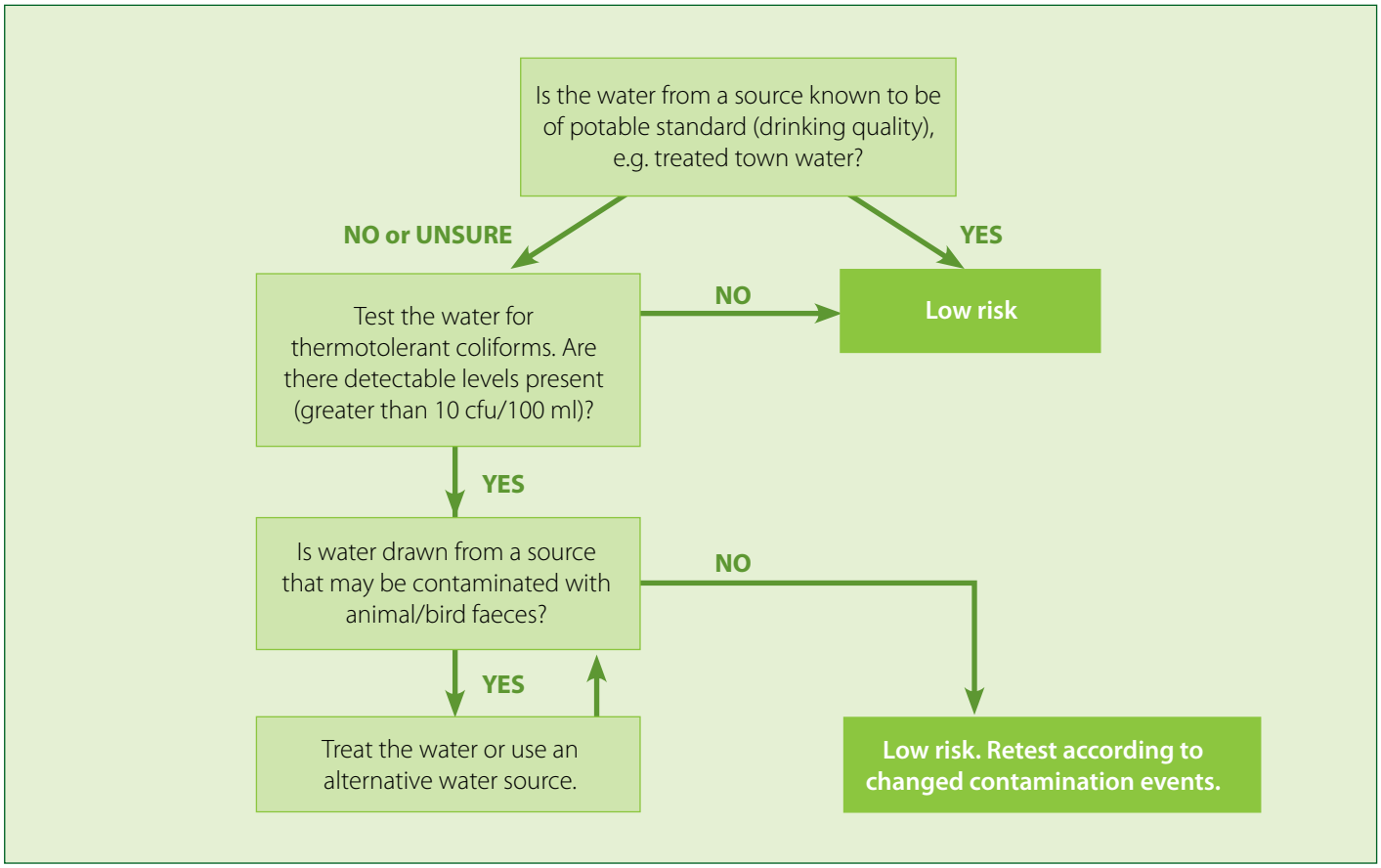
c) Water used during or after harvest

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

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

Water applied during or after harvest to produce with an inedible skin generally poses a low risk of contamination of the edible portion. However, cross contamination of hands and cutting knives can occur in food service and home kitchens if there is gross contamination of the skin. Where gross contamination may occur (for example, water from a dam beside an animal feedlot), test a sample of the produce using E. coli as the indicator organism. If the level of E. coli exceeds 20 cfu/gram, either treat the water or use an alternative water source.

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



d) Water used for hand washing

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

3.5 Contamination from people

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

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

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

References

Guidelines extracted from the Australian National Food Industry Strategy Food Safety and Quality Assurance Initiative, 2004 "Guidelines for On-Farm Food Safety for Fresh Produce" Second Edition, Department of Agriculture, Fisheries and Forestry, 2004.

The Good Bug Book 2nd Edition (2001) Australasian Biological Control; and Cotton IPM Guidelines 2001 Field Guide.

Guidelines for On-Farm Food Safety for Fresh Produce (2004) Australian National Food Industry Strategy Food Safety and Quality Assurance Initiative 2004 Second Edition, Department of Agriculture, Fisheries and Forestry, 2004.

VietGAP General Regulation 2008 (Resolution No. 379, issued on 28 January 2008 by the Ministry of Agriculture and Rural Development, Vietnam.

VietGAP Regulations for Certification of Production Facilities for Safe Vegetables, Fruits and Tea (2008) refer to Resolution No. 84/2008/QD-BNN, issued on 28 July 2008 by the Ministry of Agriculture and Rural Development, Vietnam.

VietGAP Regulations for Production Management and Business for Safe Vegetables, Fruits and Tea (2008) refer to Resolution No. 99, issued on 15 October 2008 by the Ministry of Agriculture and Rural Development, Vietnam.

Appendix 1

Impact of insecticides on natural enemies found in brassica vegetables

Impact of insecticides on natural enemies found in brassica vegetables

Information provided is based on the current best information available from research data.

Users of insecticides should check the label for registration in their particular crop and State, and for rates, pest spectrum, safe handling and application details.

INSECTICIDES	PESTS ✓ Indicates a pest targeted by at least some products in the insecticide group as at July 2005.									RATING OF INSECTICIDE IMPACT ON NATURAL ENEMIES OVERALL*
	Parasitic wasps		Predators							
Active Ingredient	Diamondback moth	Centre Grub	Cabbage Cluster Caterpillar	Cluster Caterpillar	Heliothis	Cabbage White Butterfly	Aphids	Thrips	Silverleaf Whitefly	**The Natural Enemies Assessed:** • Larval, Egg and Pupal Parasitoids • Predatory Beetles • Predatory Bugs • Lacewings • Spiders
Bacillus thuringiensis (Bt)	✓	✓	✓	✓	✓	✓				★★★★★ SOFTEST
pirimicarb (Pirimor®)							✓			★★★★★
pymetrozine (Chess®)							✓		✓	★★★★
spinosad (Success®, Entrust®)	✓	✓	✓		✓	✓				★★★★
emamectin benzoate (Proclaim®)	✓					✓				★★★☆
imidacloprid (Confidor®) soil									✓	★★★☆
indoxacarb (Avatar®)	✓				✓	✓				★★★☆
chlorfenapyr (Secure®)	✓					✓				★★★
endosulfan	✓		✓	✓	✓R*	✓	✓			★★★
fipronil (Regent®)	✓		✓			✓				★★☆
imidacloprid (Confidor®) foliar							✓	✓	✓	★★☆
organophosphates	✓R	✓	✓	✓	✓R*	✓	✓	✓		★★☆
methomyl (Lannate®, Marlin®, Nudrin®, Electra®)		✓	✓	✓	✓R*	✓				★★
synthetic pyrethroids	✓R	✓	✓	✓	✓R*	✓	✓	✓	✓	★ HARDEST

✓ = a pest targeted by at least some products in the insecticide group as at July 2005
R = known resistance in most states

R* = known resistance in QLD & NSW

★ **Rating:** derived from an average toxic effect on all the natural enemies by the product group after spraying

* Acknowledgements: The authors gratefully acknowledge the following people for permission to use data from their research; Mo & Baker; Endersby, Ridland & Guo; Wilson, Holloway, Mensah & Murray. The Good Bug Book 2nd Edition, published by Australasian Biological Control; and Cotton IPM Guidelines 2001 Field Guide.

Appendix 2

VietGAP: the general regulation (*Resolution no. 379, issued by MARD*)

(Resolution No. 379, issued on 28 January 2008 by the Ministry of Agriculture and Rural Development)

Chapter I
The general regulation

1. Amended scope and applicable subjects

- Amended scope: This process is to be used to produce safe fresh fruits and vegetables, to prevent and limit the risks of contamination adversely affecting environmental and human health, socio-welfare of people in food production, and the harvesting and handling of products post harvest.
- Applicable subjects: VietGAP applies to individuals and organisations including foreign countries involved in production, and businesses involved in checking and certifying the safety of vegetable and fresh fruit products in Vietnam.

VietGAP aims to:

- Expand the responsibilities of organisations and individuals involved in the production and management of food safety.
- Stipulate conditions to be followed by organisations and individuals involved in production and VietGAP certification.
- Ensure explicit identification of products and traceability of products to their origin.
- Improve the quality and efficiency of vegetable and fruit production in Vietnam.

2. Explanation of terms

- VietGAP (Vietnamese Good Agricultural Practices) are the principles and procedures to guide organisations and individuals in: producing, harvesting, and processing fresh vegetables and fruit safely; improving product quality; ensuring social welfare and the health of producers and consumers; environmental protection; and ensuring traceability of product to its origin.
- VietGAP for the safety of vegetables and fresh fruits are based on the ASEAN GAP, EurepGAP/ GLOBALGAL and FRESHCARE. The aims are: to create favourable conditions for Vietnamese vegetables and fruits to be exported to the region, ASEAN markets and to the rest of the world; and to move towards sustainable agricultural production.
- Organisations and individuals are: a business, the administrative unit or cooperative and farmer-householders who manage the production according to the model of economic farms, and those involved in production, sales, testing and certification of the safety of vegetables and fruit products in accordance with VietGAP.

Chapter II

Contents of the good agricultural practices for producing safe fresh vegetables and fruits

1. Assessment and selection of production zones

- Regional production of vegetables and fruits, in accordance with VietGAP, and the suitability of the conditions of production should be assessed with regard to current State regulations pertaining to chemical, biological and physical contamination risks. In the case of the regulations not being met, there must be a proven basis for overcoming or reducing the potential risk.
- Vegetable production areas with a high risk of chemical, biological or physical contamination which cannot be overcome, are not eligible for VietGAP certification.

2. Seed and grafting rootstocks

- The original source of seed and grafting rootstocks has to be clear, and authorised by the State production licensing agencies.
- Details of seed and grafting rootstocks that come from self-production must be fully recorded, including seed processing, seedling processing, chemical use, time, processor's name and purpose of processing. In the case of seeds and grafting rootstocks being bought from outside, there should be a record of the origin including the names and addresses of organisations and individuals, date of purchase, quantity, type, and method of seed and grafting rootstock processing, if applicable.

3. Management of soil and growing media

- Each year, conduct an analysis and assessment of potential risk to land, under current State standards.
- It is necessary to have in place measures to control land erosion and degradation. These measures must be recorded and stored in a database.
- If it is necessary to handle a potential risk from soil or other media, the producer should seek the advice of an expert. The measures and processes to be followed should be recorded and stored in a database.
- Do not graze or feed animals in such a way that it could cause contamination of the water source and soil in the production region. If required, the animal farming and processing methods must ensure that waste does not cause contamination to the environment or to the product after harvest.

4. Fertilisers and additives

- For every crop, there must be an evaluation of the risk of chemical, biological and physical contamination. Use of fertilisers and additives must be recorded and stored in a database. If the risk of contamination from the use of fertilisers or additives is recognised, measures must be taken to minimise the risk of contamination to vegetables and fruits.
- Select fertilisers and additives to reduce the risk of contamination to vegetables and fruits. Only the types of fertiliser included in the legal list are allowed for production and trade in Vietnam.
- Do not use untreated organic fertilisers. Where an organic treatment process is in place, record the time and method of processing. For organic fertilisers, keep a record of the names and addresses of organisations and individual suppliers and the date, quantity, type and method of processing.
- Tools for fertilisation must be hygienic, cleaned after use and maintained regularly.
- Contained areas and equipment for mixing and packaging fertilisers and additives must be built and maintained to ensure minimal risk of contamination to water resources in the production region.
- Maintain records of bought fertilisers and additives (specify origin, product name, date and quantity purchased).
- Maintain records when using fertilisers and additives (specify date of use, fertiliser name, location, application rates, method of application and the name of the user).

5. Water for irrigation

- Irrigation water for production and postharvest processing of vegetables and fruits must meet Vietnamese standards.
- Assessment of the risk of chemical and biological contamination from water used for: irrigation, pesticide spraying, storage, processing, product handling, cleaning and sanitation, must be recorded and stored in a database.
- If the water being used does not meet production standards, it must be replaced with another water source. Only use water after handling and inspection that achieves the required quality. Methods to process and test results should be recorded and saved in a database.
- Do not use industrial wastewater or wastewater from hospitals, concentrated residential areas, breeding farms, cattle and poultry slaughter and processing areas, or fresh night-soil.

6. Chemicals (including pesticides)

- Workers and producers must be trained in safe use of pesticides.
- If using pesticides and growth hormone chemicals, seek advice from a plant protection specialist.
- IPM and ICM should be used to minimise the use of pesticides.
- Only buy pesticides from shops or suppliers which hold a current business license, issued by the appropriate authority.
- Use only pesticides which are included in the permitted list for each type of vegetable or fruit in Vietnam.
- Use chemicals in accordance with the instructions on the label or instructions of the State authorities to ensure the safety of production areas and products.
- Withholding period must accord to the correct usage instructions for pesticides on the goods label.
- Any residual amounts of chemical and pesticide mixtures must be treated so as to ensure the safety of the environment.
- After each spray treatment, the tools must be cleaned and undergo regular maintenance and inspection. Water should be treated after use so as to avoid environmental pollution.
- Storage of chemicals must be in accordance with the regulations, in a building that is cool and secure and is locked. There must be first-aid guidelines and first-aid equipment on site. Only responsible persons may gain access into the storage area.
- Do not store liquid pesticides above pesticides which are in a powder form.
- Chemicals need to be kept in their original packaging and contained in specific bins with clear labels. If the chemicals do not have their original packaging, the container bins used must specify the full chemical name, directions for use as per the original packaging, and the chemical origin.
- If chemicals are expired or prohibited, this must be specified in the records in order to track and maintain in a safe place, until the chemicals are processed according to the State regulation.
- Records must be kept of each chemical application (chemical name, reason for use, date, dosage, method, time of isolation and user's name).
- Maintain records of chemical purchases and use (chemical name, seller, date of purchase, quantity, expiry date, manufacturing date and date of use).
- Do not re-use packaging or chemical container bins. The packaging and bins must be collected and stored in a safe place until they are processed according to the State regulation.
- If the chemical residue in vegetables exceeds the allowed maximum, the harvest and sale of the product must be stopped immediately. Identify the cause of the contamination and take urgent measures to reduce or prevent the pollution. This must be recorded in detail in the database.
- Types of fuels including gas, oil and other chemicals should be stored separately in order to limit the risk of contamination to vegetables and fruits.
- Regularly check the implementation of production processes. Check chemical residues in vegetables and fruits at the request of customers or authorities. The analyses must be performed in a laboratory that meets the national or international laboratory standard for pesticide residue testing.

7. Harvesting and postharvest processing

Equipment, materials and containers

- After harvesting, products should not be in direct contact with soil. Distribute product to consumers as soon as possible after harvesting.
- Equipment, container bins or other materials in direct contact with vegetables and fruits should be made from material that does not contaminate the product.
- Equipment or container bins must be cleaned before use.
- Receptacles for waste disposal, pesticides and other dangerous substances must be marked clearly and not be used for the produce.
- Carry out regular inspection and maintenance of equipment and tools to limit the risk of contamination to the produce.
- Equipment, bins containing vegetables and fruits, and harvesting and packing materials must be stored separately from chemicals, fertilisers and additives, and measures must be taken to limit the risk of contamination.

Designing the factory and storage room

- It is necessary to design and construct buildings and factories for planting, processing, packing and storage that minimise the risk of contamination.
- The area for processing, packaging and storing vegetable products should be separate from tanks, oil, fat and agricultural machinery to prevent the risk of contamination to the product.
- Waste processing and drainage systems must be designed to minimise the risk of contamination to the production area and water resources.
- Light bulbs in the region's processing and packaging areas must be protected against breakage. In the case of a light being broken and glass falling into the product, remove the product and clean the area.
- Equipment and tools for packaging processed products must have safety barriers to ensure workers are protected.

A sanitary factory

- The factory must be sanitised by hygienic chemicals, in accordance with the relevant regulations so as not to cause contamination of the product or environment.
- Regularly clean the factory, equipment and tools.

Protect against plague

- Cattle and poultry livestock must be isolated from the area used for processing, packaging and storing vegetables and fruits.
- There must be measures in place to prevent carriers of infection entering the area of processing, packaging and storage.
- Baits and traps must be placed to ensure there is no contamination to vegetables and fruits, container materials and packaging. There must be notices displayed, which clearly show the location of baits and traps.

Personal hygiene

- Workers must be given training in personal hygiene. This must be recorded in the database.
- Wall posters regarding personal hygiene regulations must be displayed in easy-to-see locations.
- There should be toilets and washing facilities and these should be maintained to ensure hygenic conditions for workers.
- Waste from toilets must be processed.
- ***Processed products***
- Only use chemicals, products and wax film that are permissible for postharvest processing.
- Water used for postharvest processing of vegetables and fruits must meet quality standards, in accordance with regulations.

Storage and transportation

- Transport vehicles must be cleaned before loading products into container bins.
- Do not store or transport products with other goods that pose a risk of contamination.
- Storage areas and transportation must be regularly decontaminated.

8. Management and treatment of waste

- There must be in place management and treatment measures for waste and wastewater from the production, preliminary processing, and product storage areas.

9. Workers

Work safety

- People assigned to manage and use chemicals must have the appropriate knowledge and skills, as well as recording skills.
- Organisations and individuals must be equipped with medicines and first-aid equipment and any worker poisoned by chemicals must be taken to the nearest hospital.
- Producers must have documentation available to guide first-aid treatment as well as guidelines for the storage of chemicals.
- People assigned to process and use chemicals or access newly sprayed areas, must be equipped with protective clothing and equipment.
- Protective work clothing must be washed clean and not stored with pesticides.
- Warning notices must be displayed when there is new chemical spraying in areas of vegetable and fruit production.

Working conditions

- The working structures should be cool and the workload reasonable.
- Working conditions must conform to health regulations. Workers must be provided with protective clothing.
- Facilities, equipment and tools (manual and mechanical) must be checked regularly and maintained to avoid any risk of accident to the user.
- There must be measures in place to reduce the risk of injury from moving or lifting heavy items.

Social welfare for workers

- The age of workers must be in accordance with Vietnamese law.
- Housing and living conditions for workers must be equipped with basic services that conform to the regulations.
- Salaries and other remuneration for workers must be reasonable, in accordance with the Vietnamese Labour Law.

Training

- Before commencing employment, workers must be informed of any risks related to health and safety.
- Workers must be trained in: safe use of the equipment and tools; rendering first-aid in the case of an accident; safe use of chemicals; and personal hygiene.

10. Record-keeping and storage of records, product origin and traceability, and product recall

- Organisations and individuals producing vegetables and fruits according to VietGAP must keep full and up-to-date records, including production diary, log of plant protection, fertiliser use, sales etc.
- Producers of vegetables and fruits that follow the VietGAP must self-audit or employ an auditor to internally review the implementation of processes for production, recording and archiving records. If a requirement is not being met, appropriate measures must be taken to overcome the problem and a record of this stored in the database.
- A database must be established for every detail of VietGAP practices and it must be stored at the production facility.
- Records must be retained for at least two years, or longer if required by a client or management agency.
- All products produced under VietGAP must be clearly identified with location and production batch number. Location and production batch numbers must be recorded and stored in the database.
- Product packaging and container bins should be labelled to make it easy to trace the origin of the product.
- For each shipment of product, record the issue date and receiver's name and location. Records must be maintained for each batch of product.
- When product is contaminated or at risk of contamination, the contaminated plot must be isolated from others and distribution halted. If the product was distributed, consumers must be informed immediately.
- Causes of contamination must be investigated and measures implemented to solve the problem and prevent re-infection. This must be recorded in the database.

11. Internal audit

- Producers of vegetables and fruits should conduct an internal audit at least once a year.
- The audit must be conducted in accordance with the VietGAP evaluation checklist. After the inspection is complete, organisations, individuals or inspectors should sign the auditing result checklist. Checklists completed in-house and checklists (random and periodic) completed by State authorities must be saved in the database.
- Organisations and individual producers that follow the VietGAP must summarise and report test results on quality management, as required.

12. Complaints and complaint resolution

- Organisations and individual producers that follow the VietGAP must make complaint forms available when requested by customers.
- When there is a complaint, producers that follow the VietGAP must take responsibility for its resolution according to the law, and save the complaint and resolution results in the database.

Further Information

* For information on VietGAP Regulations for Certification of Production Facilities for Safe Vegetables, Fruits and Tea, refer to *Resolution No. 84/2008/QD-BNN, issued on 28 July 2008 by the Ministry of Agriculture and Rural Development*.

* For information on VietGAP Regulations for Production Management and Business for Safe Vegetables, Fruits and Tea, refer to *Resolution No. 99, issued on 15 October 2008 by the Ministry of Agriculture and Rural Development*.

Appendix 3

List of approved chemicals for use in cabbage production in Vietnam

Pesticides approved for use in Vietnam

(From the Decision No. 31/2006/QD-BNN April 27, 2006 of Ministry of Agriculture and Rural Development)

Common Name	Trade Name
Abamectin	Abamine 1.8 EC, 3.6EC
	Abasuper 1.8EC, 3.6EC
	Abatimec 1.8 EC, 3.6EC
	Abatox 1.8EC, 3.6EC
	Aceny 1.8 EC, 3.6EC
	Alfatin 1.8 EC
	AMETINannong 1.8EC, 3.6EC
	Azimex 20 EC
	Binhtox 1.8 EC
	Brightin 1.0 EC; 1.8 EC; 4.0EC
	Catcher 2 EC
	Catex 1.8 EC, 3.6 EC
	Dibamec 1.8 EC
	Fanty 2 EC, 3.6 EC
	Hifi 1.8 EC
	Nimbus 1.8 EC
	Nockout 1.8 EC
	Plutel 0.9 EC
	Queson 0.9 EC, 1.8 EC, 3.6 EC, 5.0EC
	Reasgant 1.8 EC; 3.6 EC
	Shertin 1.8 EC, 3.6 EC, 5.0 EC
	Sieusher 1.8 EC, 3.6 EC
	Silsau 1.8EC, 3.6EC, 10WP
	Tập Kỳ 1.8 EC
	Tungatin 1.8 EC; 3.6 EC
	Vertimec 1.8 EC

Common Name	Trade Name
Abamectin + *Bacillus thuringiensis* (var.kurstaki)	Kuraba 1.8 EC
Abamectin + *Bacillus thuringiensis* (var.kurstaki)	Kuraba 3.6 EC
Abamectin + *Bacillus thuringiensis* (var.kurstaki)	Kuraba WP
Abamectin	Song Mã 24.5 EC
Acephate	Anitox 50 SC
	Monster 40 EC,75 WP
	Orthene 97 Pellet
	Mopride 20 WP
Alpha - cypermethrin	Sapen – Alpha 5 EC; 5EW
Artemisinin	Visit 5 EC
Azadirachtin	Aza 0.15 EC
	A-Z annong 0.03EC, 0.15EC; 0.3EC
	Bimectin 0.5 EC
	Jasper 0.3 EC
	Neem Bond - A EC (1000ppm)
	Neem Nim Xoan Xanh green 0.15 EC; 0.3 EC
	Nimbecidine 0.03 EC
	Vineem 1500 EC
Azadirachtin + Matrine	Biomax 1 EC

Common Name	Trade Name
Bacillus thuringiensis (var. aizawai)	Aizabin WP
	Aztron DF 35000 DMBU
	Bathurin S
	Map - Biti WP
	Xentari 15 FC; 35WDG
Bacillus thuringiensis (var.kurstaki)	An huy WP
	Biobit 16 K WP; 32 B FC
	Biocin 16 WP; 8000 SC
	Comazol WP
	Crymax ® 35 WP
	Delfin WG (32 BIU)
	Dipel 3.2 WP, 6.4 DF
	Firibiotox – P
	Firibiotox – C
	Forwabit 16 WP; 32 B FC
	Halt 5% WP
	Jiabat 15WDG
	Kuang Hwa Bao WP
	MVP 10 FS
	Newdelpel WP; WDG
	Shian 32 WP
	Thuricide HP; OF 36 BIU
	Vi – BT 16000 WP; 32000 WP
	V.K 16 WP, 32 WP
Bacillus thuringiensis **var. kurstaki + Granulosis virus**	Bitadin WP
Bacillus thuringiensis (var. aizawai) ***+ Nosema sp***	Cộng hợp 16 BTN; 32BTN
Bacillus thuringiensis var. 7216	Amatic SC
	Pethian (4000 IU) SC
Bacillus thuringiensis var. T 36	Cahat 16 WP
Beauveria bassiana **Vuill**	Beauveria
Chlorfluazuron	Atabron 5 EC
Cnidiadin	Hetsau 0.4 EC
Cypermethrin	SecSaigon 5 EC; 5ME; 10EC; 10ME; 25EC; 30EC; 50EC
Deltamethrin	Decis 2.5 EC, 25 tab
Diafenthiuron	Pegasus 500 SC (Polo 500 SC)
Dinotefuran	Oshin 20 WP

Common Name	Trade Name
Emamectin benzoate	Dylan 2EC
	Emaplant 0.2 EC; 1.9EC
	Emaben 0.2 EC
	Ematox 1.9EC, 5WG
	EMETINannong 1.9EC
	Hoatox 0.5ME
	Newmectin 0.2 ME
	New Tapky 0.2 EC
	Proclaim 1.9 EC
	Thianmectin 0.5 ME
	Tungmectin 1.0EC; 1.9EC
Etofenprox	Trebon 10 EC, 20 WP, 30EC
Eucalyptol	Pesta 5 SL
Fipronil	Legend 5 SC; 800 WG
	Regent 0.2 G; 0.3 G; 5 SC; 800WG
	Supergen 5SC; 800WG
	Tango 50SC, 800WG
Garlic juice	BioRepel 10 DD
	Bralic 1.25DD; 12.5DD
Indoxacarb	Ammate 150 SC
Isoprocarb + Dimethoate	BM - Tigi 5 H
Lufenuron	Match 050 EC
Matrine	Asin 0.5 EC; 0.5SL
	Faini 0.3 SL
	Lục Sơn 0.26 DD
	Sokupi 0.36 AS
	Sotox 0.3 SL
Matrine + Abamectin	Abecyny 2.2 EC
Novaluron	Rimon 10EC
Nuclear polyhedrosis virus (NPV) - S.l	ViS1
Nuclear polyhedrosis virus (NPV) - Ha	ViHa
	Pounce 1.5G; 10EC; 50EC
Pirimicarb	Ahoado 50WP
Propargite	Comite(R) 73 EC
Pyridaphenthion	Ofunack 40 EC
Rotenone	Dibaroten 5 WP, 5SL, 5G
	Fortenone 5 WP
	Limater 7.5 EC
	Rotecide 2 DD
	Vironone 2 EC

Common Name	Trade Name
Rotenone + Saponin	Dibonin 5 WP, 5 SL, 5G
Spinosad	Spinki 25SC
	Success 25 SC
	Wish 25SC
Thiamethoxam	Actara 25 WG; 350FS
Thiosultap – sodium (Nereistoxin)	Shachong Shuang 18 SL; 50SP/BHN; 90WP; 95 WP
Tralomethrin	Scout 1.4SC; 1.6EC; 3.6 EC
Trichlorfon (Chlorophos)	Terex 50EC; 90 SP
Virus 104 virus/mg + *Bacillus thuringiensis* (var.kurstaki)	V - BT
Acrylic acid + Carvacrol	Som 5 DD
Chlorothalonil	Carben 50 WP, 50 SC
	Carbenvil 50 SC
	Daconil 75 WP, 500 SC
	Forwanil 50 SC; 75 WP
Copper Oxychloride + Kasugamycin	New Kasuran 16.6BTN
	Canthomil 47 WP
	Kasuran 47 WP
Copper Oxychloride + Zinc sulfate + *Streptomycin sulfate*	PN - balacide 32WP
Copper Oxychloride* + *Zineb	Vizincop 50 BTN
Cucuminoid + Gingerol	Stifano 5.5SL
Cytokinin (Zeatin)	Sincocin 0.56 SL
Flusulfamide	Nebijin 0.3 DP
Fthalide + Kasugamycin	Kasai 21.2 WP
Kasugamycin	Kasumin 2 L
	Fortamin 2 L
Mancozeb	Dithane F - 448 43SC; M - 45 80WP
	Forthane 43 SC, 80WP; 330FL
	Man 80 WP
	Manozeb 80 WP
	Penncozeb 75 DF, 80 WP
	Sancozeb 80 WP
	Thane - M 80 WP
	Timan 80 WP
	Vimancoz 80 BTN
	Vimonyl 72 BTN

Common Name	Trade Name
Ningnanmycin	Diboxylin 2 SL
Oligo - Alginate	M.A Maral 10 DD, 10WP
Oligo - Alginate + Chitosan	2S Sea & See 12WP, 12DD
Oligo - sacarit	Olicide 9 DD
Oxolinic acid	Starner 20 WP
Pencycuron	Moren 25 WP
	Vicuron 25 BTN, 250 SC
Polyoxin B	Ellestar 10WP
Propineb	Antracol 70 WP
	Newtracon 70 WP
***Streptomyces lydicus* WYEC 108**	Actinovate 1 SP
***Streptomyces lydicus* WYEC 108 + Fe + Humic acid**	Actino – Iron 1.3 SP
Streptomycin sulfate	Poner 40T; 40SP
Thiophanate - Methyl	Top 50 SC, 70 WP
	Toplaz 70 WP
Triadimefon	Bayleton 250 EC
Trichoderma spp	Promot Plus WP (*Trichoderma spp*; Promot Plus DD (*Trichoderma koningii* + *Trichoderma harzianum*
	$TRiB_1$
Validamycin (Validamycin A)	Validacin 3L, 5L, 5SP
	Vanicide 3SL, 5SL, 5WP, 150WP
	Vida(R) 3 SC, 5WP
	Vigangmycin 3 SC, 5 SC, 5 WP
Methyl eugenol + Hexadecenyl acetate 1+ Dodecenol butenoate	Vidumy 10DD
Spray adjuvant	
Azadirachtin	Dầu Nim Xoan Xanh Xanh 0.15EC
Esterified vegetable oil	Hasten â 70.4 L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