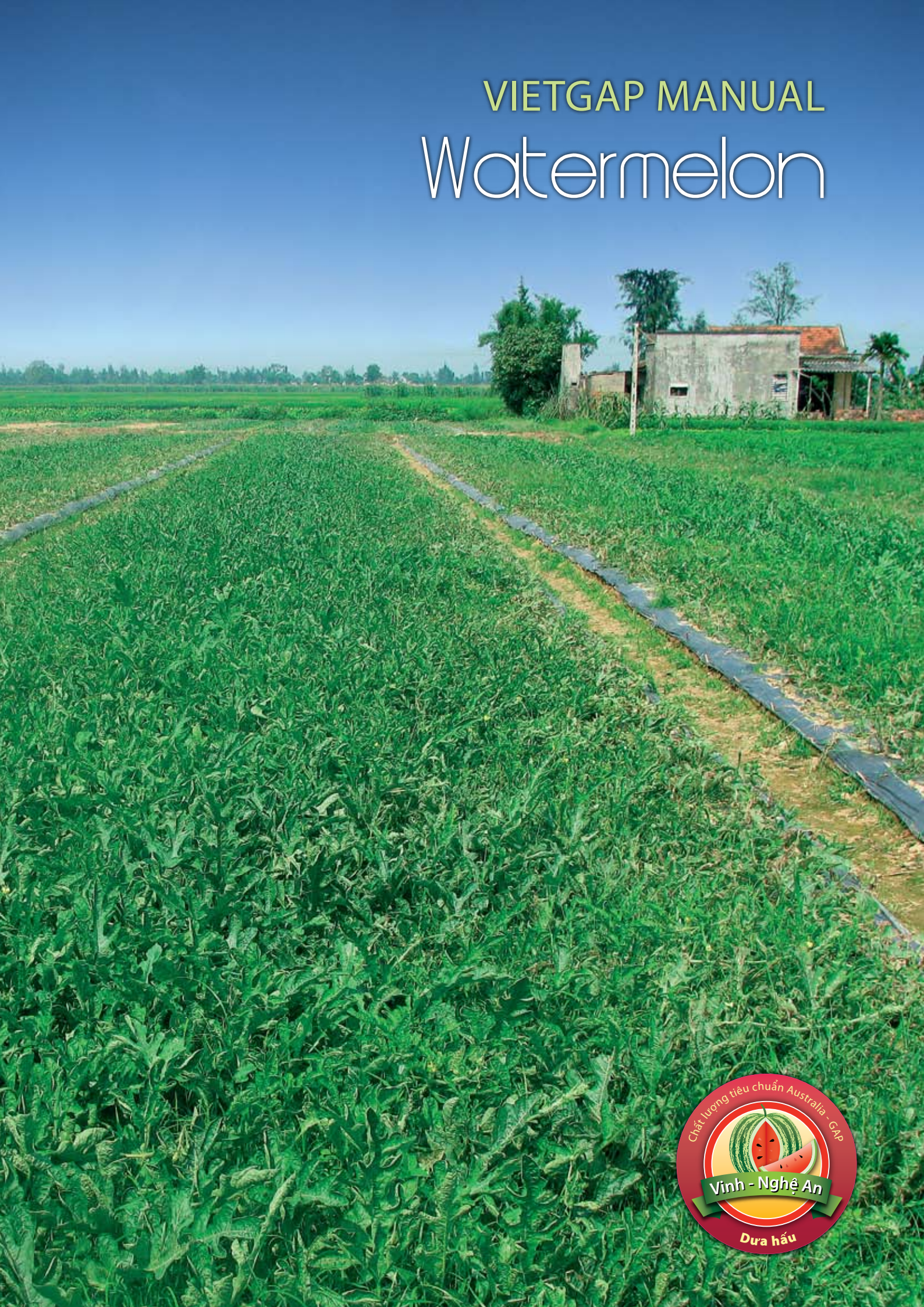
VIETGAP MANUAL

Watermelon



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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 watermelon 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 watermelon GAP manual, they will fulfil this requirement of VietGAP and be safe for consumers to eat.

How to use the VietGAP Manual: Watermelon

The information in this manual is presented in several parts:

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

Watermelon 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. VietGAP: The General Regulation (Resolution No. 379, issued by MARD)
- Appendix 2. List of approved chemicals for use in watermelon production in Vietnam.

Watermelon

Best Practice Guide

The purpose of this guide is to assist farmers in growing high quality watermelons which do not contain excessive pesticide residues. Fruit 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
- Watermelons must not contain high levels of pesticide residues

Agronomy

Characteristics of watermelon

Watermelon is a spreading vine with shallow roots. When the vine is about 1m long, first-level branches will appear. There are three flower types: male, female and hermaphrodite. Watermelon flowers are pollinated by insects and take from 65 to 85 days from sowing to maturity, depending on the temperature at planting time.

Climatic and environmental requirements

The suitable temperature for watermelon growth is 25–35°C. Optimum temperature for seed germination is 30–35°C. Watermelon prefers full sun and long days and can cope with low air humidity but not a shortage of water. Low light levels, short days, low temperatures and a high number of rainy days all adversely affect the quality of the fruit and render it vulnerable to infection from disease.

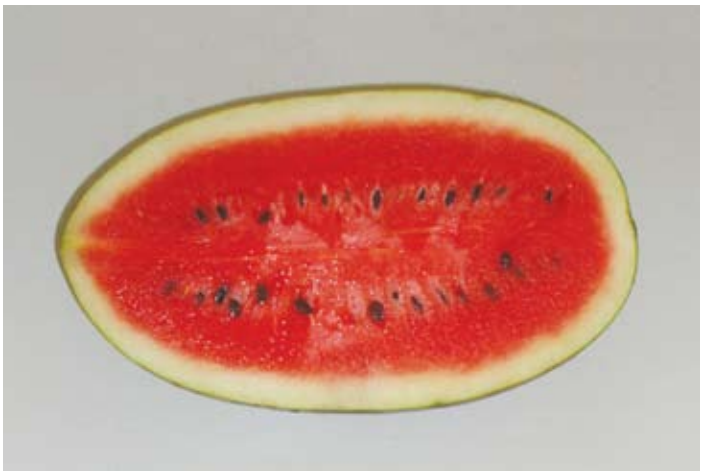
North Vietnam:

Spring season: Higher prices are available for watermelons which are planted from early February to early March and harvested from late April to the end of May. However, the risk of problems with the crop such as disease is higher during this period due to variable weather conditions.

Summer season: The main summer crop in the north should be sown from early March to the end of May, and the fruit will be ready to harvest from June to the end of August. This is a more reliable period for watermelon production, but prices may be lower than for the spring crop.

South Vietnam:

Watermelons can be grown all year round.



Soil for watermelon

Watermelon growing is best suited to well drained soils which are not prone to water logging and which do not flood after heavy rain. The most suitable soil types are sandy loam, light loam or medium clay, with a topsoil at least 20–30 cm deep.

The watermelon production region must be isolated by a safety zone of at least 2 km from heavy industrial and hospital sites, and at least 200m from urban residential areas. Soil must not contain quantities of heavy metals or residues of toxic chemicals that exceed maximum allowable levels.

Soil preparation

Soil should be ploughed, weeded and the pH adjusted to between 5.5 and 7.0. There are two methods of forming planting beds. One is to form a narrow bed about 2m wide and plant watermelons along one side only. The second is to form a larger bed about 4m wide, and plant watermelons on either side of the bed. In both cases, the planted row of watermelons should be adjacent to an irrigation channel.

Plastic mulch

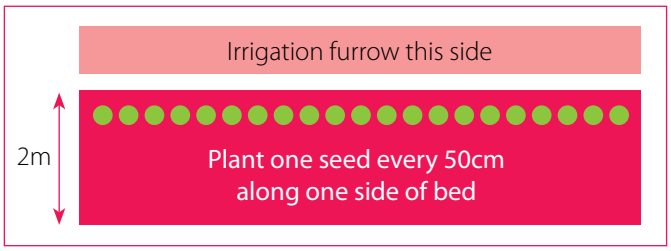
After the beds are prepared, black and silver plastic mulch should be laid over the soil surface. The plastic should be laid with the black side facing the soil to prevent weed development, and the silver side facing upward to reflect sunlight and reduce heat absorption. The reflective side also helps to deter sucking insects. After the plastic has been laid, it should be perforated with 10cm diameter holes to allow for planting.

A rice-straw mulch over the soil is a good idea if plastic mulch is not used. This should be laid out across the whole bed after the plants have emerged, or immediately after planting if seedlings were used.

Planting Option 1

Construct a raised bed about 2m wide and put plastic much over the soil surface. On either side of the bed, form an irrigation channel about 0.4m wide. This will give a total row width between centres of about 2.4m.

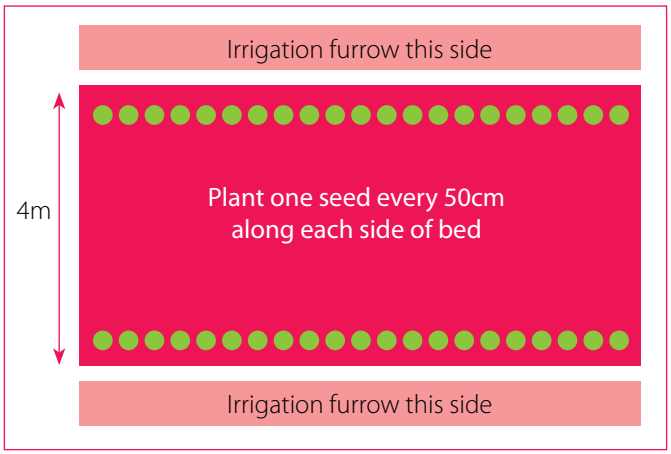
Plant 1 watermelon seed or 1 watermelon seedling every 50cm along the windward side of the bed – about 30cm from the edge. The seed should be planted about 2cm deep at as even a depth as possible, covered over with soil and watered in. After about 1 week, replant any seeds which have not germinated. Keep the soil moist until the seedlings have emerged and are well established.



Planting Option 2

Construct a raised bed about 4m wide and put plastic much over the soil surface. On either side of the bed, form an irrigation channel about 0.4m wide. This will give a total row width between centres of about 2.4m.

Plant 1 watermelon seed or 1 watermelon seedling every 50cm along each side of the bed – about 30cm from the edge. All other treatments are the same as for Planting Option 1.



Crop establishment

A watermelon crop can be established either by sowing seeds directly into the soil (direct seeding) or by transplanting seedlings.

It is important to use only healthy, disease-free seeds. Imported seed must be checked by customs officials and comply with plant quarantine regulations. Seed supplied by reputable seed companies should be disease-free and any necessary seed treatments will already have been applied. Seed which has been saved from a previous crop should be treated before planting with a suitable fungicide.

Variety selection

Seed companies have recently introduced various types of new hybrid seeds. However, it is important that the variety selected is suitable for the climate, soil and product quality.

The main watermelon varieties are:

Hac My Nhan (HMN): dark green skin and elongated shape, with an average weight of 2.5–5 kg / fruit. The flesh can be either red or yellow. Examples of Hac My Nhan varieties that suit the sandy soils in the North Central region are CS202 (red flesh) and CN46 (yellow flesh), An Tiem, Thuy Loi and Mat Troi Do. They are high quality (12–13° Brix), uniform size, meet supermarket standards, and are popular with consumers.

Seedless watermelon: These are triploid plants which require a seeded (diploid) plant for pollination. There should be 1 seeded plant for every 3 seedless watermelon plants, distributed evenly throughout the crop.

Stimulation of seed germination

Soak seeds in warm water (45–50°C) for 4 to 6 hours, depending on weather conditions. After soaking, when the seed coats are soft, mix with ash or sand to clean the surface, and then wash in water. Remove excess water. Place the seeds in an incubator for 24 to 36 hours. The temperature must be kept between 32–35°C.

The seeds should be sown as soon as a small white root can be seen emerging from the seed coat.

Direct seeding

In regions with favourable weather conditions, the germinated seed should be sown directly into the field. This will result in strong root systems and faster growth. Plant the germinated seed directly into the prepared beds; 1 seed per hole at about 1cm deep and cover with soil.

Growing seedlings

In regions with weather conditions that are not favourable for planting directly into the soil, watermelons can be grown as seedlings in the nursery and then transplanted into the field.

The germinated watermelon seeds should be sown into small pots or cells of a seedling tray which contains a suitable potting media. Soil is not good enough for seed germination.
A good mix is:

- 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, the seeds sown into small depressions which are made in the media, and then covered with vermiculite.

The planted trays should be watered and 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, once per week.

Planting 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.

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.

Before seedlings are planted in the field, treat with Sherpa® 0.1% as a guard against insects.

Grafted seedlings

It is possible to graft watermelon seedlings onto disease-resistant rootstocks. This is very useful if the soil is high in clay and poorly drained. Grafted watermelons seedlings, which have resistance to Fusarium wilt are available in Vietnam.

Planting density and spacing

Double-bed or single-bed arrangements can be used for watermelons in Vietnam (see planting options 1 & 2 on page 7).

Spacing between rows: 2.5m between rows on single beds or 4.5m between rows on double beds

Spacing between plants: 40–45cm

Plant density: 9000–11,000 plants/ha

Note: Agricultural land in Vietnam is commonly measured in sao or cong. In the northern region around Hanoi, 1 sao = 360 m^2. In the central region (Vinh to Hue), 1 sao = 500m^2. In the south, 1 cong = 1000m^2.

Fertiliser

The rate of basal fertiliser dressing should be adjusted according to plant density, i.e. adjusted for the spacing between plants and rows.

Total fertiliser requirement:

Agricultural lime: 400–500kg/ha if required to adjust soil pH
Animal manure (NB use aged, not fresh): 20 tonnes/ha
Compost (NPK approx. 8:10:3): 1000–1200 kg/ha
Urea: 60-80 kg/ha
Potassium (potassium chloride): 100-120 kg/ha

Dressing method

Dressing	Timing	Compost (NPK 8:10:3) *(kg/ha)*	Urea *(kg/ha)*	Potassium chloride *(kg/ha)*	Animal manure *(tonnes/ha)*
Basal dressing	Before sowing	500–600			16-20
Side dressing 1	20 DAP	500–600			
Side dressing 2	35–40 DAP		30–40	50–60	
Side dressing 3	45–50 DAP		30–40	50–60	

*Absolutely **DO NOT** use fresh manure, which contains microorganisms that can: cause disease; generate heat that can damage plant roots; and compete with plants for available nitro fertiliser. Absolutely **DO NOT** apply human waste (faeces or urine), even diluted in water, to watermelon field.*

Growing practices

Irrigation and water management

Watermelon plants need irrigation to produce the best results. Water should be applied regularly, so that the plants do not become water stressed at any time during their growth. When plants are young and with small, actively growing root systems, irrigation may not need to be very frequent provided the soil profile is fully wet before planting. Roots can supply water by expanding into moist soil. This encourages a strong root system.

Once plants are flowering, they will need to be irrigated more often to avoid water stress. In sandy soils, the plants may need to be irrigated every second day, and sometimes every day if the weather is hot and windy. On clay soils with a higher water holding capacity, irrigation may only be required every 2 to 3 days. Do not apply frequent small irrigations as this encourages a weak root system and also root diseases. It is better to allow the plants to use the available water in the soil, and then water the soil profile back to field capacity.

If there is no fresh water from wells, water from rivers or ponds can be used for irrigating provided it is not polluted.

Water can be applied using furrows dug alongside the planting beds. Make sure the plants are close enough to the furrows so that water can move into the plant root zone to effectively supply them with water.

Branch pruning

When the plant reaches the 3–4 true leaf stage, start pruning. Select 2–3 good stems per plant (including 1 branch and 1 or 2 sub-branches) and remove the others. Use a bamboo stick to hold the branches and direct them across the bed at 90° to the direction of the rows.

Pollination

Watermelon flowers need to be pollinated by hand or by bees before they will produce a fruit. To pollinate the female flowers by hand, remove a male flower (the smaller flowers close to the crown of the plant) and rub the pollen onto receptive female flowers. The best time for pollination is from 6:00 – 9:00am. If bees are used, you will need to place bee hives in close proximity to the watermelon plants.

Fruit selection

Select fruits which are formed in the 8th to 12th node, or about 1.5m from the crown of the plant. Fruit shape should be long and well formed without defects. Keep 2 fruits per vine and remove other fruit. Do not remove leaves or parts of the stem as these leaves help to feed the developing fruit.

Pest and disease management

Watermelon - Pest and Disease Management

Key pests, diseases and their symptoms

Pests:

- **Melon Aphid & other aphid species:** Adults, eggs and larvae are very small, (yellowish white for melon aphid). They are found mainly on buds or back surface of leaves, sucking plant resin.
- **Thrips *(Thrips spp.):*** Adult is a small black insect about the size of a mosquito. Larvae feed on the leaf epidermis, with their rasping mouth parts creating small zigzag patterns on the leaf surface.
- **Heliothis *(Helicoverpa spp.):*** Very young grubs tend to concentrate in masses on back surface of leaves. Older larvae disperse and cause more widespread damage, eating all the way through leaves.

Diseases:

- **Damping off complex:** Favoured by wet and cool weather. Appearance of white stains to white-gray, then developing into a large white layer.
- **Fusarium root & crown rot:** In seedling plants, leaves become pale and wilt. A yellow or red rot at the base of the stem, wilting of the plant and fruit rotting, accompanied by white fungal growth are common symptoms. Soft tissues at the base of the plant become black and disintegrate, leaving only the stringy water-conducting fibres which are usually reddish-brown in colour. Sometimes known as foot rot.
- **Fusarium wilt:** In the first instance, older leaves wilt and become chlorotic. The wilting is most evident during the hottest period of the day, with recovery during the cooler hours. Gumming (red-brown) and brown discolouration of the vascular tissue, especially near the crown follows.
- **Powdery mildew:** Small, circular white, powdery patches occur on leaves, runners and leaf-stalks. These are generally observed first on the undersides of leaves, but eventually cover both surfaces. Yellow spots may form on upper surfaces opposite powdery colonies on the lower leaf surface. Affected leaves gradually turn yellow, then become brown and papery and die.
- **Downy mildew:** Favoured by moist conditions such as rain, fog and heavy dews and therefore downy mildew is more common in districts of higher rainfall. This disease often occurs in the early spring-summer.

- **Gummy stem blight:** This disease can affect all above-ground parts of the plant at any growth stage from seedlings to mature vines with fruit. Seedlings die rapidly after infection of either the hypocotyls or cotyledons. Leaves display brown to black spots on the leaves. Stems near the crown may have bleached appearance and exude a brownish gum. However, similar symptoms appear with charcoal rot and Fusarium wilt. This form of the disease may cause plant death.
- **Anthracnose:** Brown to black spots on leaves, at first near the veins. Long dark spots develop on stems and round sunken spots develop on fruit. Fruit symptoms may develop in transit.
- **Sudden wilt:** Occurs late in the season and normally when a lot of fruit is present. Initially plants wilt in the heat of the day, even when soil moisture is good. Plants appear to recover at night but the same process is repeated and becomes worse over several days until plants do not recover at all. Disease progression is rapid, hence the name sudden wilt. Infected plants have a poorly established root system. Some of these roots appear thicker than normal.
- **Bacterial wilt:** Wilting of whole lateral or individual leaves occurs. These leaves take on a dull green appearance. Sometimes there is evidence of leaf damage at an infection site caused by feeding insects, although normally the feeding damage is too minor to see. Soon the wilting symptoms spread to adjacent leaves until the entire lateral is affected. This is because the wilt progresses along the vascular system from laterals back towards the main stem, eventually killing the whole plant. Cut stems ooze a sticky, stringy white exudate while the stem itself is not significantly discoloured.

Pest or Disease	Infestation level assessment	Control Strategy
All Lepidoptera larvae, including, Heliothis	Insect scouting: look for eggs and larvae. Begin scouting *7 days after transplanting*, then check each week. Threshold level for control: If 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. 4-6 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 4-6 leaf stage. **4-6 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. 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 are 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 (e.g. 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.
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 in 50-100 mL of water as a basal drench to emerging seedlings. As this product is highly systemic, under-plant drenching will result in much greater safety to a wide range of beneficial insects than postemergent 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
Thrips (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 in 50-100 mL of water as a basal drench to emerging seedlings. As this product is highly systemic, under-plant drenching will result in much greater safety to a wide range of beneficial insects than postemergent foliar sprays.
	Post-planting: Consider spraying if thrips 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®) Fipronil (e.g. Regent®) 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. As with grub sprays, a variety of older products from both the anticholinesterase group such as diazinon (e.g. Basudin®) and dimethoate (e.g. Rogor®) and syntheticpyrethroid 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.
Damping Off Complex (*Pythium, Rhizoctonia, & Fusarium spp,*)	Close attention during emergence or after transplanting during early establishment. Poor, uneven emergence or lack of vigour are all symptomatic of infection.	Damping Off is generally worse during cooler periods and when plant vigour is reduced. Pythium is favoured by wetter conditions whereas Rhizoctonia and Fusarium are favoured more by carried over-crop and weed residues. It is extremely difficult to make general recommendations on chemical control as the complex involves three very different fungi, all responding to different fungicides. By far the most responsive disease in the complex to fungicides is *Pythium spp.* Metalaxyl-m as a seed treatment (e.g. Apron® XL) or soil drench (e.g. Ridomil® Gold products) can help to control *Pythium spp*. Some newer fungicides applied as a soil drench are effective against *Rhizoctonia* in other crops but have not been evaluated specifically in watermelons. Damping Off caused by *Fusarium* remains difficult to control with fungicides.
Fusarium Wilt (*Fusarium spp,*)	Look for vines suddenly turning yellow, wilting.	Several species of *Fusarium* can be involved. Use more tolerant varieties where possible. Use varieties grafted onto tolerant rootstock. DO NOT replant severely infected areas, or use a long rotation and encourage plant material to fully decompose before replanting. There are currently no reliable control methods based on the use of fungicides.
Sudden Wilt (*Pythium & Fusarium spp,*)	Look for vines suddenly turning yellow, wilting and dying between fruit set and first harvesting.	The precise nature of this disease is not well understood. However, the two main fungi normally associated with it are *Pythium* and *Fusarium*. Water stress during fruit set seems to be the primary initiator. In Vietnam, the disease is most likely associated with excessive rainfall (in drier climates it can be associated with under-watering). There are currently no reliable control methods based on the use of fungicides.
***Fusarium* root and crown rot**	There is no effective curative strategy, only prevention.	DO NOT use seed from previously contaminated crops. To date, seed treatment fungicides do not appear to provide reliable control. Use grafted seedlings on resistant rootstock. Resistant varieties are likely to become available in the future. Fungicides are unlikely to provide reliable control. Soil fumigation can be effective but is not likely to be suitable for commune gardens in Vietnam.
Bacterial wilt (*Erwinia tracheiphila*)	Rare in watermelons but common in many other cucurbits. Disease is generally spread by a vector insect – most commonly beetles.	Most watermelon varieties appear to be fully resistant to this disease. Scout for vector insects and control with appropriate insecticides. Any affected plants should be removed and destroyed without contaminating other plants in the crop. Treating either seed or seedlings in the nursery with antibiotics such as streptomycin several days before transplanting into the field can be effective. The bacteria does not survive well in dry plant material for more than several weeks.

Pest or Disease	Infestation level assessment	Control Strategy
Downy mildew (*Pseudoperonospora cubensis*)	Sustained wet conditions or at first sign of disease – whichever comes first.	This is an extremely severe problem in Vietnam, especially during the wet season. Under severe disease pressure, metalaxylm (e.g. Ridomil® Gold products) has been proven to be the most effective fungicide in Vietnam. However, overuse will result in the development of disease resistance. Make a **maximum of three applications in any one crop and no more than two sequential sprays** before rotating to a fungicide that DOES NOT contain metalaxyl-m. Always apply metalaxyl-m in a mixture with a broad, based protectant. Products containing metalaxyl-m are normally sold co-formulated with a protectant such as mancozeb. Other products to rotate with metalaxyl-m sprays are chlorothalonil (e.g. Daconil®), cymoxanil + chlorothalonil (e.g. Cythala® 75 WP).
Gummy Stem Blight (*Didymella bryoniae*)	Sustained wet conditions or at first sign of disease – whichever comes first.	Thiophanate methyl (e.g. Topsin®-M) may be very effective but resistance to this chemistry is widespread and easily evolved from overuse. Chlorothalonil (e.g. Daconil®), is probably the best broad based protectant to establish a spray program around. Mancozeb (e.g. Dithane®) and propineb (e.g. Antracol®) can also be effective. Newer chemistry (QoI fungicides – e.g. pyraclostrobin) is also effective but likely to be quite expensive at present and prone to resistance if overused.
Powdery mildew (*Podosphaera xanthi*)	At first sign of disease.	Worst infections occur during the driest part of the year (c/w downy mildew, which favours wettest conditions). However, it is possible for both diseases to occur together during transitional periods. The most cost-effective sprays for watermelons are likely to be the EBI, particularly the triazole fungicides. There are many fungicides in this chemical class. Among the most effective against powdery mildew – myclobutanil (Mycloss®), triadimenol (e.g. Bayfidan®) and penconazole (e.g. Topas®). Overuse will favour the development of resistance, though the process is likely to involve a gradually decreasing sensitivity which can be reversed by ceasing to use these products for a time. A number of newer fungicides such as quinoxyfen (Legend®), spiroxamine (e.g. Prosper®) and the QoI fungicides (e.g. pyraclostrobin) are also effective, depending on access and pricing.
Anthracnose (*Colletotrichum orbiculare*)	At first sign of disease.	Chlorothalonil (e.g. Daconil®) is probably the best broad-based protectant. This means that regular protectant sprays of chlorothalonil applied for other diseases will likely cover infection periods for anthracnose as well. QoI fungicides such as azoxystrobin (e.g. Amistar®) are very effective but likely to be expensive. Always use clean seed or transplants. The disease survives in crop debris in the field. Don't replant watermelons in the same field for at least a year, or two years if the disease occurred in the last planting. Encourage rapid decomposition of vines after harvesting to reduce inoculums.

Scouting in Watermelons

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 carefully for disease spots and lesions on both sides of leaves, particularly on the most mature leaves for first signs of foliar infection.
3. Examine crowns and branch junctions for any early signs of vascular disease. This may appear as brown, rotten tissue or bleaching.
4. Look for insects on the underside of leaves, especially the base of the leaves, along the midrib and into the heart of the plant.
5. Make notes on your findings: include the date, insects or disease found and level of infestation, what controls were used, and rate and date of any pesticide applications.

Maximum allowable heavy metals and harmful organism levels for watermelon

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	Copper (Cu)	30
4	Tin (Sn)	40
5	Zinc (Zn)	40
6	Mercury (Hg)	0.05
7	Cadmium (Cd)	1
8	Antimony (Sb)	1

Limit of harmful microorganisms in watermelons **

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.

Harvesting and post harvest management

Watermelons should be harvested when they are mature but not over-ripe. The best way to assess maturity is to cut some fruit and look at the internal flesh. For red-fleshed watermelon, the flesh should be red but still firm and not show any signs of softening or indications of orange or yellow colouring, especially around the seeds. Other indicators of maturity include: tight skin, fruit weight in the range of 2.5 to 4 kg. You can also tap the fruit to make sure that is does not sound 'hollow', which is an indicator that it may be cracked internally. The fruit should be free of external blemishes and rots.

Take flesh samples and, using a refractometer, test the Brix, which should be between 10 and 12°, the higher the better.

If possible, harvest the fruit during cooler morning temperatures. Avoid stacking the fruit in large piles because this can damage the fruit at the bottom. The harvested fruit should be taken out of the field and kept in the shade until being packed into a covered truck for transport.

Optimum temperature range for storage and transport of watermelons is from 12 to 20°C. In Vietnam this temperature range may not always be achievable but it can be offset by minimising the time between when the fruit is harvested and when it arrives at its ultimate destination.

As soon as possible after harvest the fruit should be stacked into the truck for transport to market by placing a layer of straw on the floor of the truck. Pack the fruit firmly to prevent it rolling around and being damaged during transport.

Wash fruit using clean water, dry the skins, and then place it into cartons and pack with straw to transport to consumers. Packaging must have a label specifying the producer's name, address and other details such as harvest date, batch number etc, as stipulated under the VietGAP guidelines. This is to ensure traceability of the product to its origin.

Only consign fruit that meets customer specifications, especially with regard to weight / size, flesh maturity, skin appearance and Brix. Do not send poor quality fruit to the wholesaler or supermarket.

It is very important that the fruit is still in good condition by the time the consumer gets it home. The fruit may be several days in storage and transport and will continue to ripen over this time. Therefore, it is better to harvest fruit slightly before it is fully mature so that it is not over-ripe by the time it reaches the consumer.

Send the fruit to the wholesaler or buyer as soon as possible after harvest, within 24 hours at most. Advise the buyer when the fruit has been dispatched and make sure you supply the amount and quality that has been agreed upon.

Specifications for high quality watermelon

The specifications below are an example is a specification used by a supermarket in Australia for watermelon.
Major suppliers will probably have their own specifications, and that should be used in preference to this example.

MELON
TYPE: Watermelon
VARIETY: Various

GENERAL APPEARANCE CRITERIA	
COLOUR	*With mid-dark green background, with or without pale green striping; red-pink flesh with black seeds*
VISUAL APPEARANCE	*With bright bloom full bodied; no hollow areas when cut; rind thickness 10-15mm; no foreign matter, e.g. traces only of soil, not clumped or matter. With need for stickers with PLU and product type name, or bar code when available, per Woolworths requirements*
SENSORY	*With firm, smooth skin, not soft or coarse; sweet, crisp flesh; no 'off' odours or tastes*
SHAPE	*Oval to slightly elongated-oval. Nil with pronounced pointed ends or otherwise deformed*
SIZE	*2-5 kg*
MATURITY	*TSS > 10° Brix; firm, well coloured flesh, not pale (immature) or soft and watery (overmature)*
MAJOR DEFECTS	
INSECTS	*With evidence of live insects*
DISEASES	*With fungal or bacterial rots (Rhizopus rot, Fusarium rot, blue mould, sour rot, Anthracnose)*
PHYSICAL / PEST DAMAGE	*With cuts, splits, holes, cracks that break the skin*
TEMPERATURE INJURY	*With severe sunburn, e.g. wrinkled areas*
	With skin pitting and flesh discolouration (chilling injury)
PHYSIOLOGICAL DISORDERS	*With dark sunken area at blossom end (blossom end rot)*
	With faded colour and softened skin (dehydrated, senescent)
	With hollow centre or soft, mealy flesh (overmature)
MINOR DEFECTS	
PHYSICAL / PEST DAMAGE	*With >2 healed insect holes/punctures to skin (not >3mm wide or 3mm deep)*
	With superficial bruising (<2mm deep), slightly darker colour/skin still firm, affecting >8 sq cm; no soft/moist, deep-seated bruises
	With healed, shallow (<2mm) light coloured scarring/pest chewing affecting >8 sq cm; no deep (>2mm) soft/moist insect scarring
	With groundmark >30% of visible surface area; with uniform pale colour only; not dark and/or blotchy
PHYSIOLOGICAL DISORDER	*With attached stems exceeding 10mm length*
SKIN MARKS / BLEMISHES	*With dark blemish, ie. reddish/brown areas/patches (e.g. due to chilling) or other solid marks, collectively affecting >8 sq cm of surface area*
	With scattered light blemish, e.g. sand marks, healed scratches (<2mm deep), mild sunburn (bleached greyish), collectively affecting >10% of visible surface
CONSIGNMENT CRITERIA	
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 watermelon specifications 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.

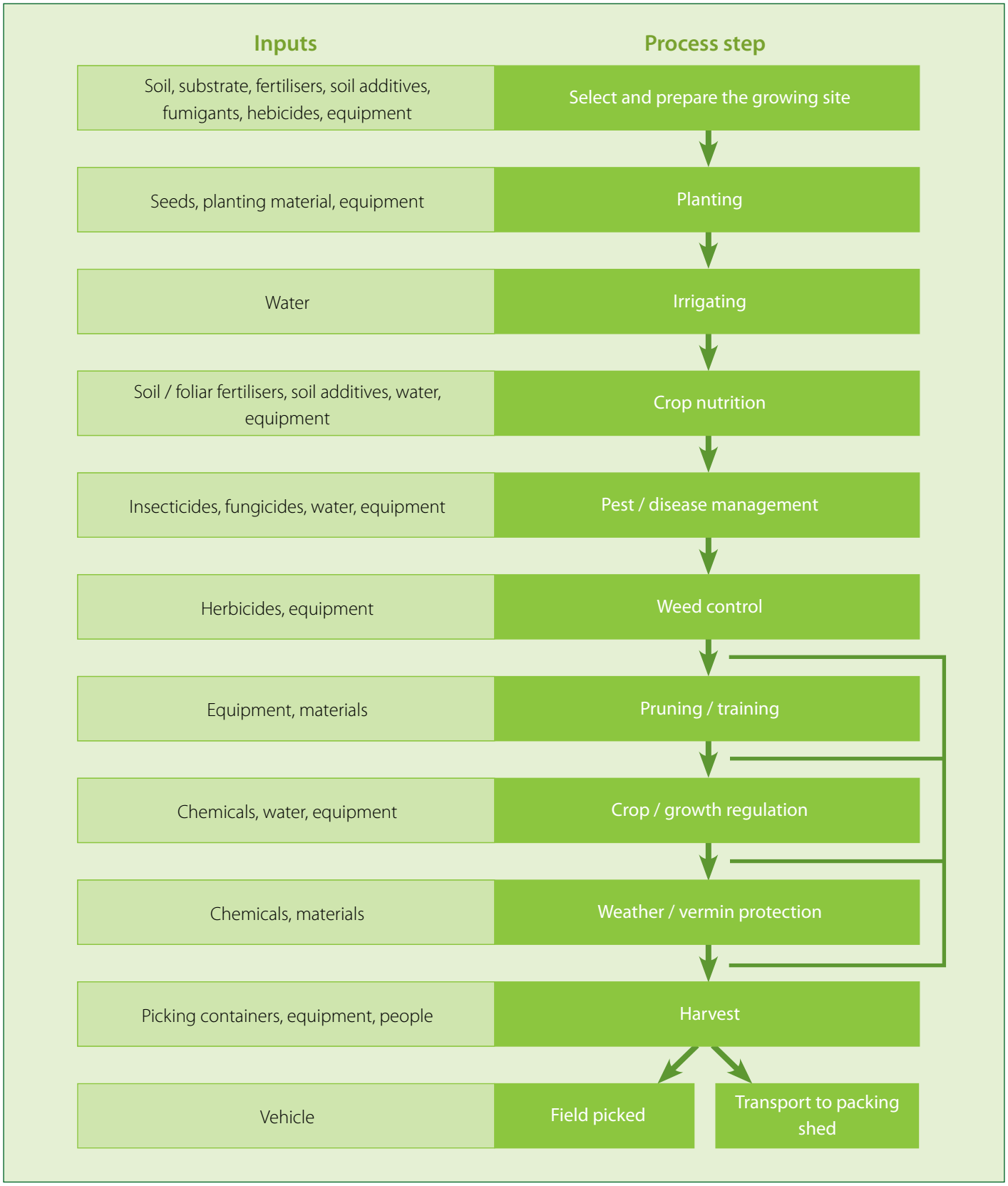
Type of hazard	Hazard	Cause of contamination
Microbiological **Note:** There are many microorganisms in the environment – some are totally harmless, some are beneficial, such as those used in yoghurt and cheese-making, and others are the cause of food spoilage and rotten fruit and vegetables. Only a 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

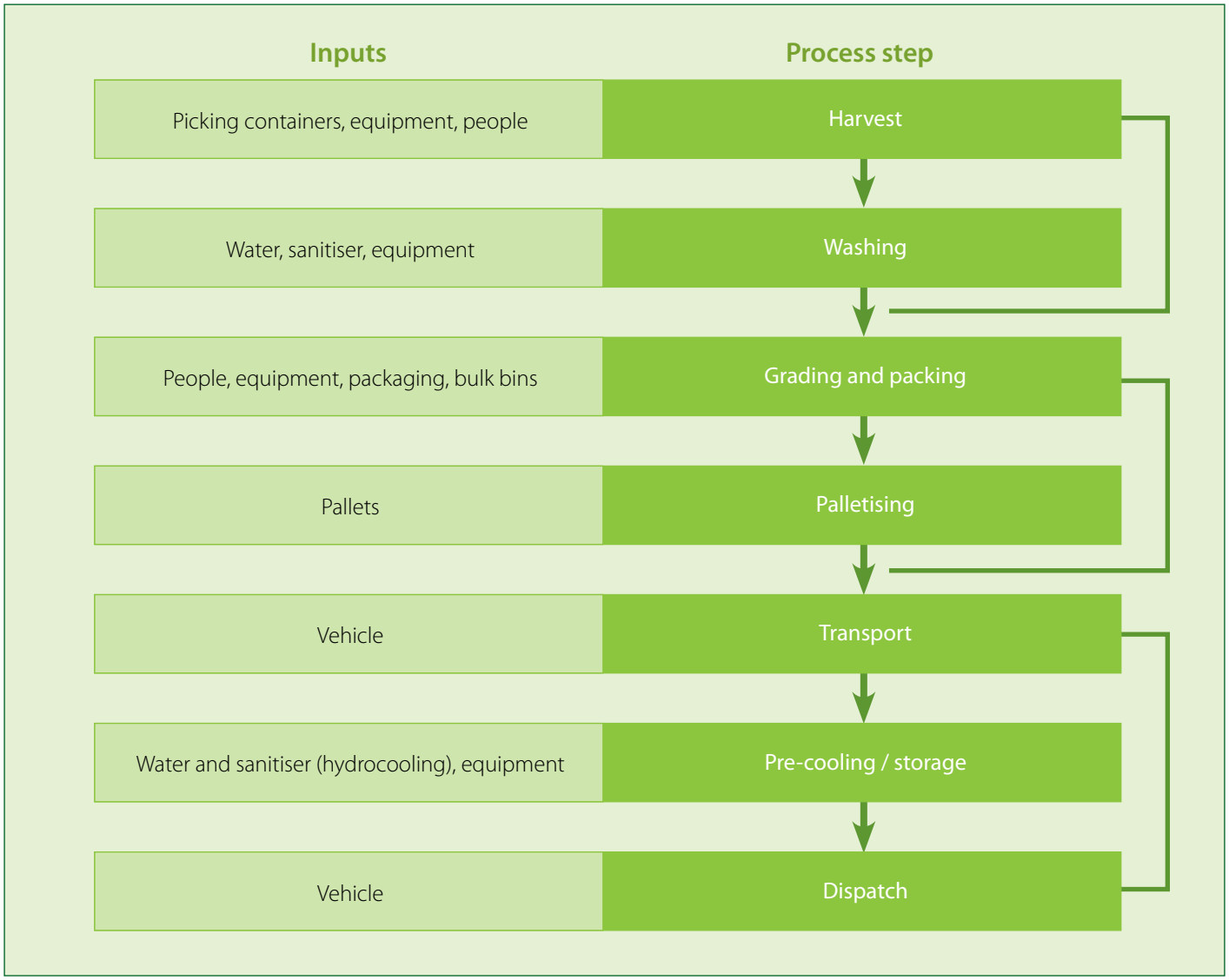
Growing the crop – process flow

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.



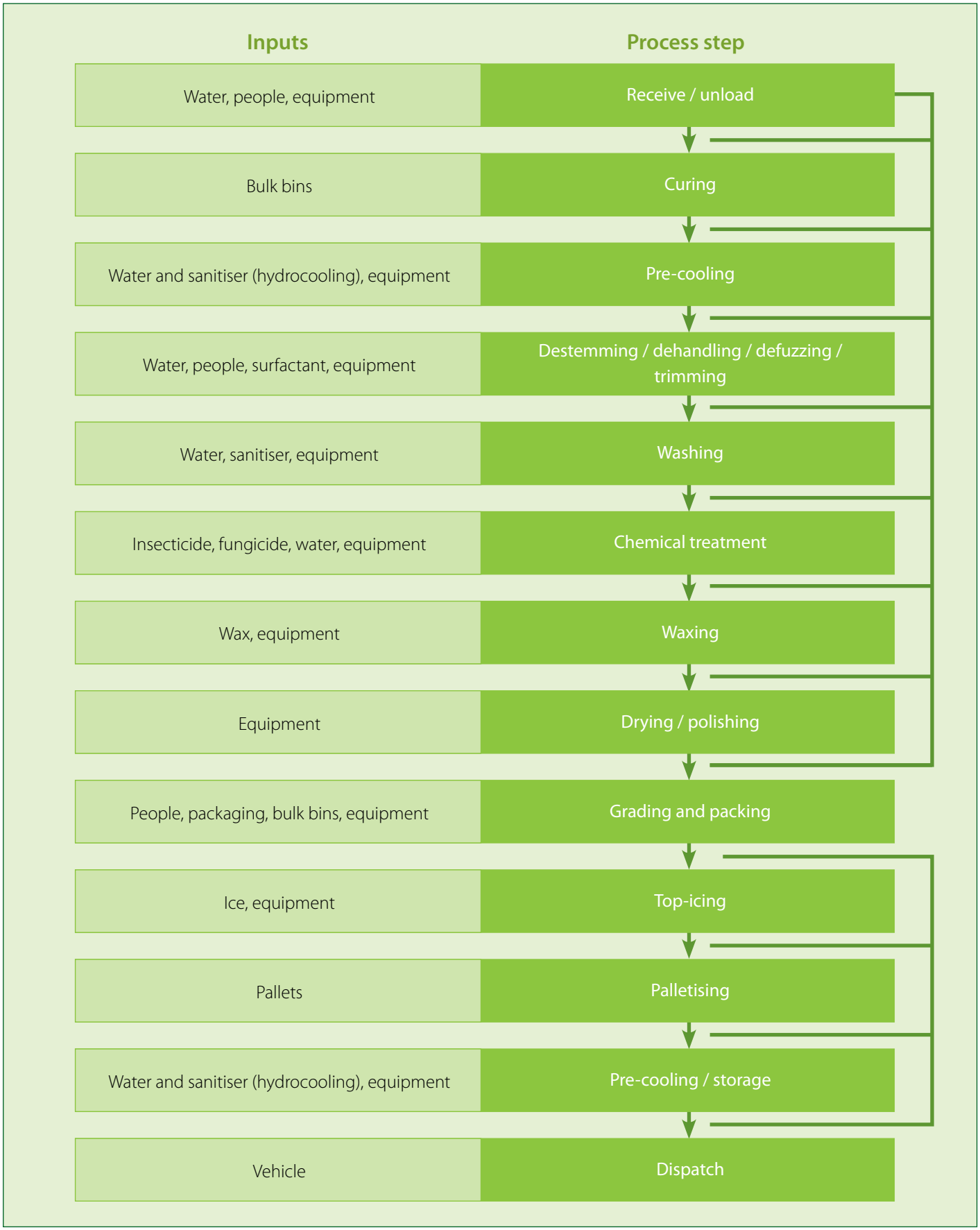
Field packing – process flow

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.

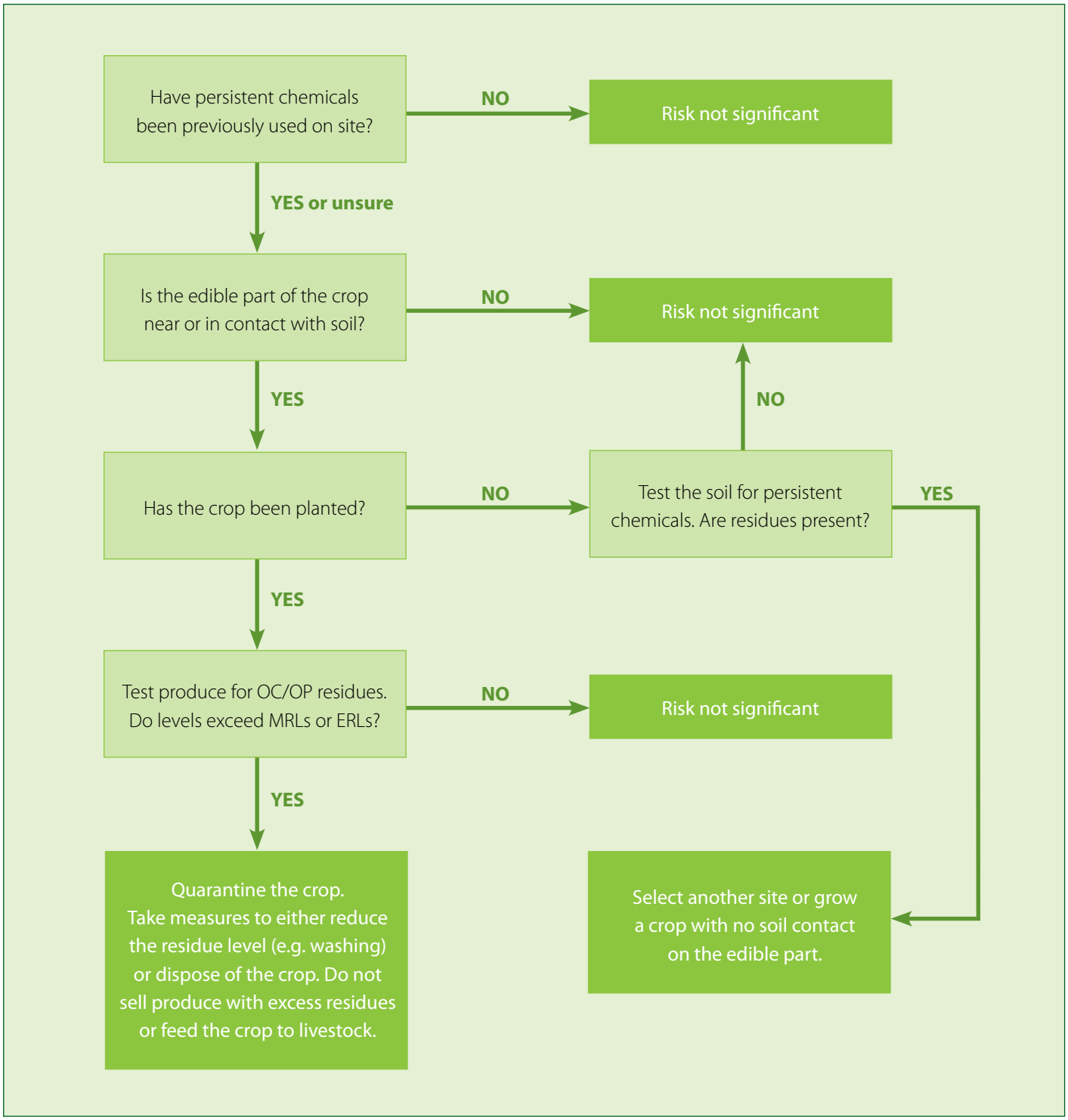
Naturally occurring toxins

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.

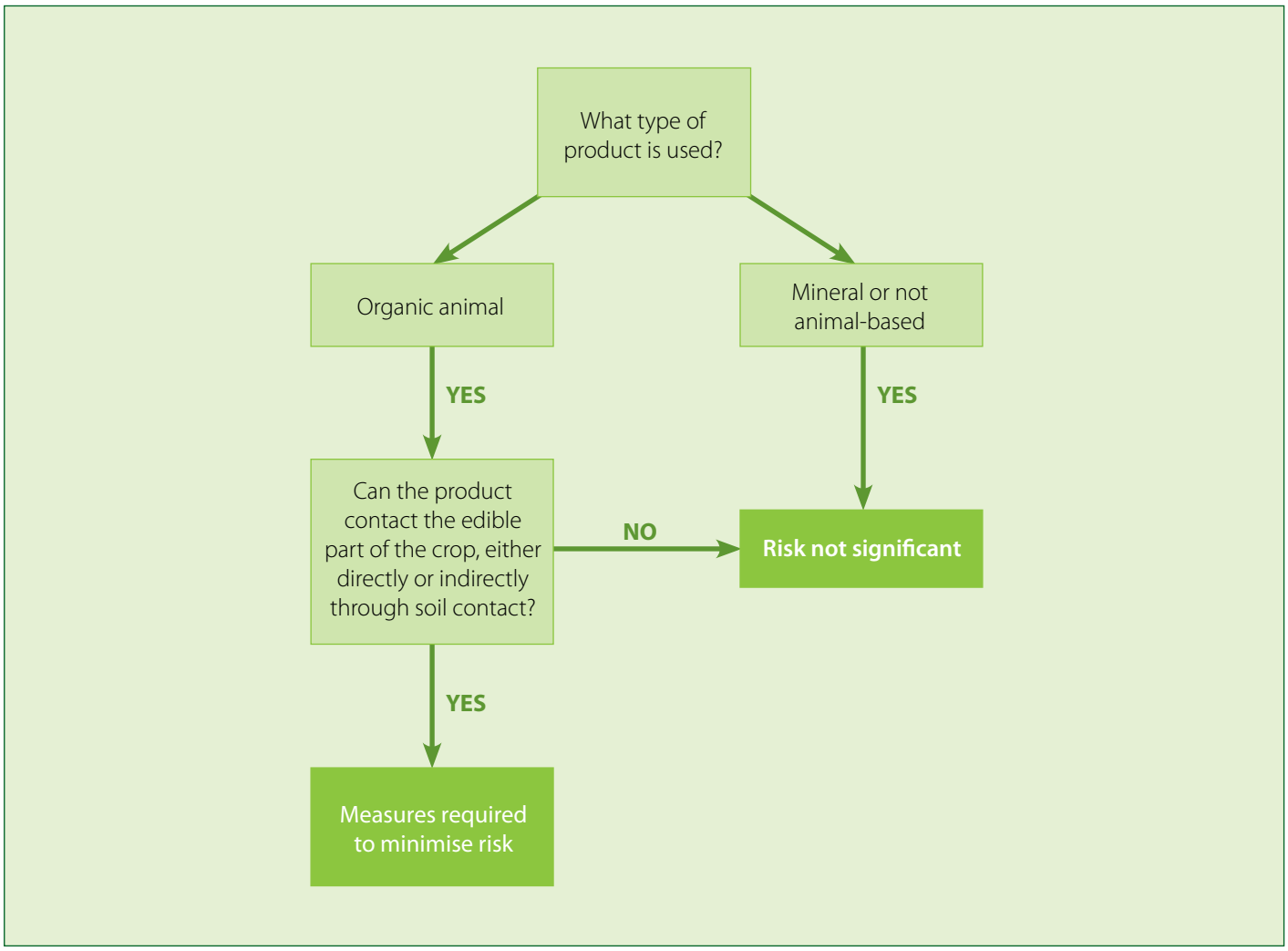
Microbiological contamination

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.


What type of product is used?
Organic animal
Mineral or not animal-based
YES
YES
Can the product contact the edible part of the crop, either directly or indirectly through soil contact?
NO
Risk not significant
YES
Measures required to minimise risk

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.

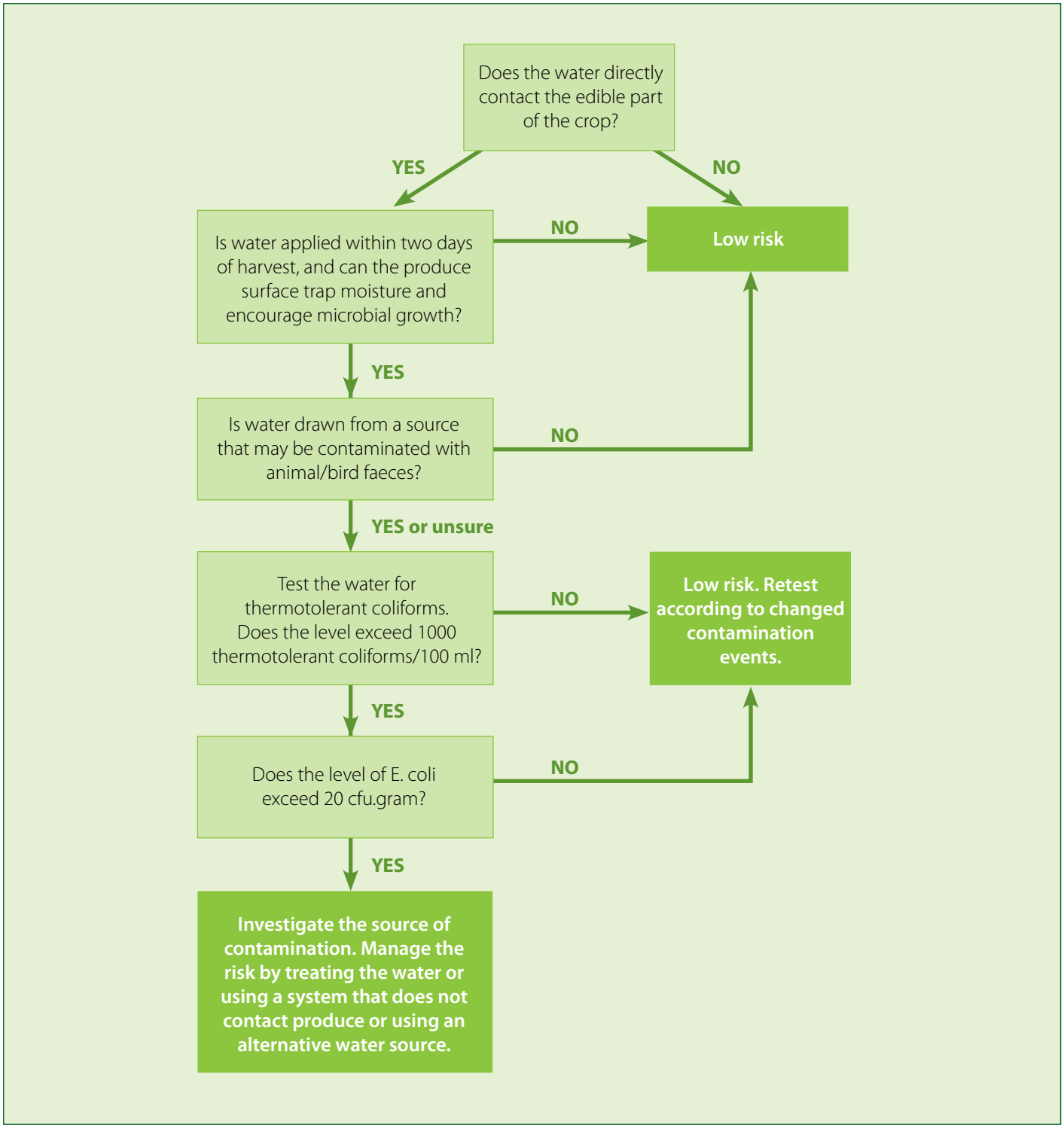
It is important to carefully review the best water treatment for the operation, based on sound technical advice, and following the manufacturer's guidelines. Treatment of water with a sanitiser should be monitored to ensure that it achieves the desired level of microorganism control. A record should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



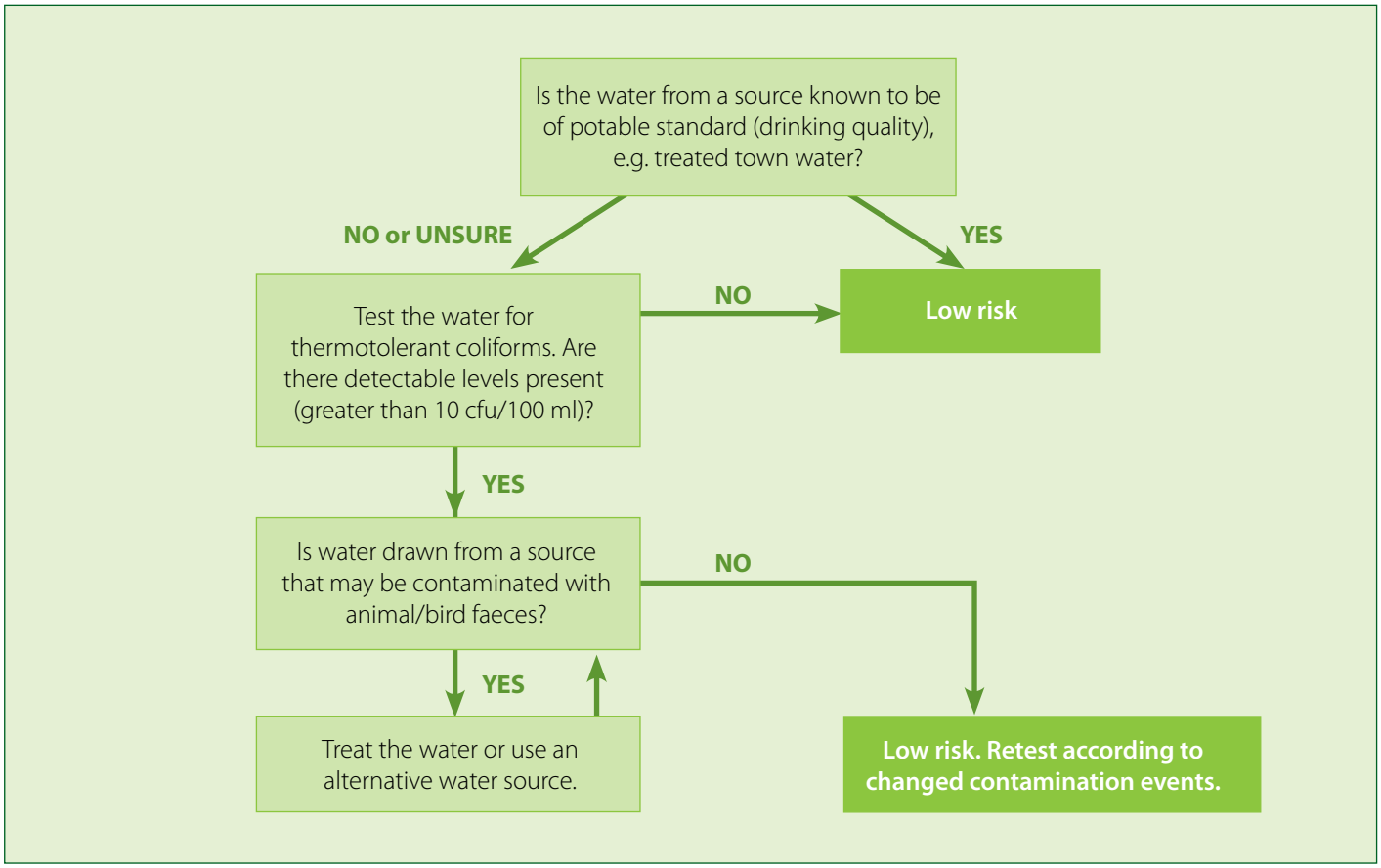
c) Water used during or after harvest

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
- Handwashing
- 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

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 2

List of approved chemicals for use in watermelon 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 – Tỏi Tỏi 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.I	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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