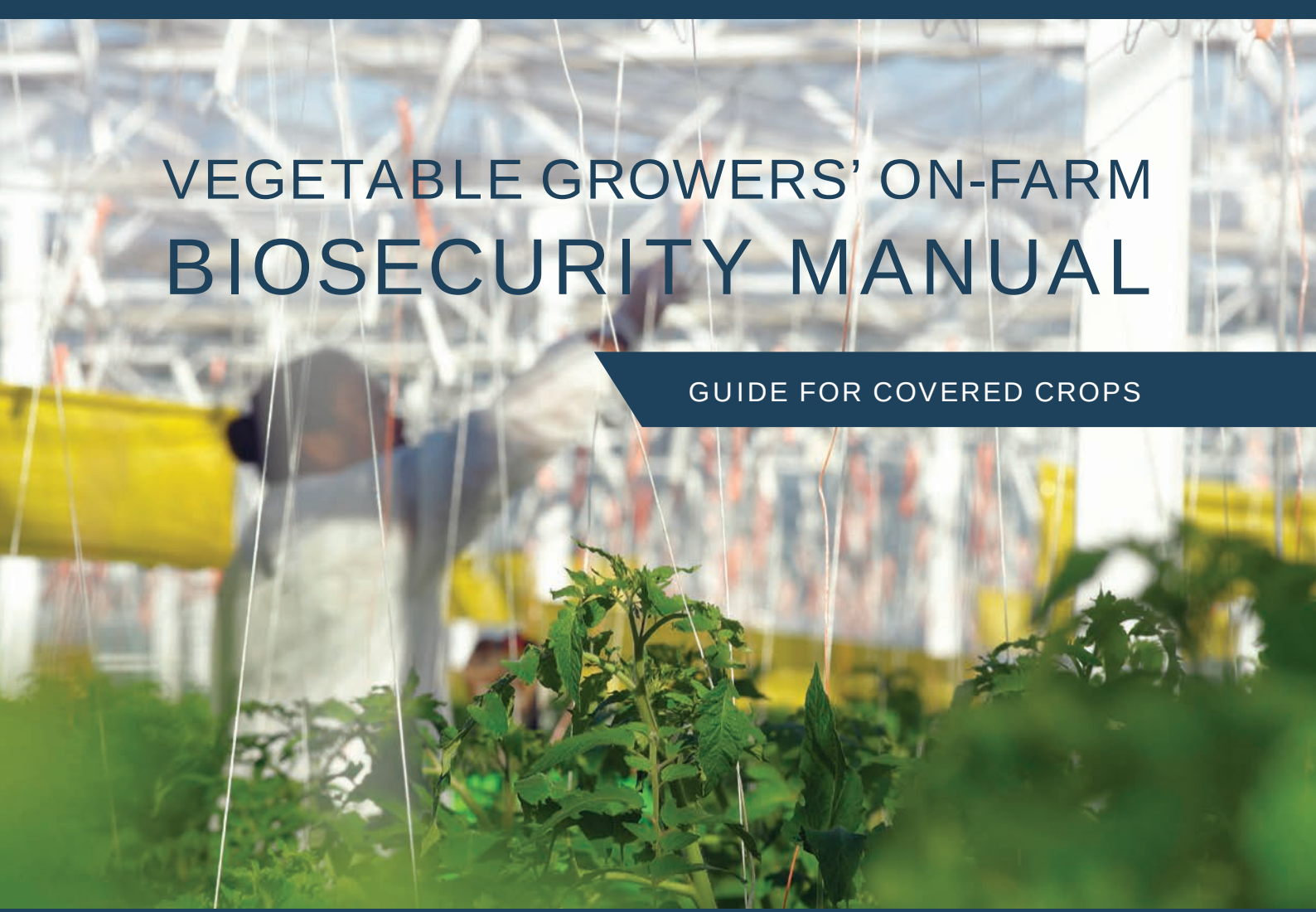


VEGETABLE GROWERS' ON-FARM BIOSECURITY MANUAL

GUIDE FOR COVERED CROPS

ACKNOWLEDGEMENTS

Stakeholders:

Vegetables NEW ZEALAND Inc

Process Vegetables NZ

TomatoesNZ

onions NEW ZEALAND INC An integrated industry

New Zealand ASPARAGUS COUNCIL

BUTTERCUP SQUASH COUNCIL INC

Co-funder:

Agriculture & Investment Services
Ministry for Primary Industries
Manatū Ahu Matua

This Sustainable Food & Fibre Futures project is proudly supported by Agriculture & Investment Services, part of the Ministry for Primary Industries.

REPORT THE UNUSUAL

CATCH IT

SNAP IT

REPORT IT

MPI exotic pest and disease hotline

0800 80 99 66

FIND A PEST

To download the app and learn more, head to:

www.findapest.nz

Help keep New Zealand free of new weeds and pests

CONTENTS

SECTION
01

INTRODUCTION

THE PURPOSE AND FUNDAMENTALS OF GOOD GREENHOUSE BIOSECURITY MANAGEMENT

What is biosecurity?

Biosecurity measures help to protect your property from new and exotic pests, diseases and weeds, and minimises the impact of pests that have already established in New Zealand.

Good biosecurity is a set of practices carried out to protect your property from unwanted pests.

What is the purpose of this manual?

This covered crop growers' biosecurity manual guides vegetable growers on good biosecurity practices. This manual allows growers to assess the biosecurity systems they have in place, and directs growers to information sources and further steps to consider.

Why is good biosecurity important?

Poor biosecurity practices can lead to the introduction, spread and establishment of unwanted pests and diseases, on your property and others that you interact with. The better your biosecurity practices, the better your ability to manage pests and diseases, and protect your crops.

Biosecurity makes good financial sense:

1. We now share the costs of eradication with the Government. The cost is much lower if the pest/disease is spotted early and only a small area needs to be treated.
2. Eradication will not always be possible once a pest/disease has spread and established.
3. New organisms have the potential to cause export market access restrictions and domestic movement restrictions. The more confined a response, the better chance industry has at maintaining as much trade as possible. Vegetable exports were worth approximately $700 million in 2019.

Examples of biosecurity responses in the vegetable and wider horticulture sector are included in section 10 Page 37. Some invasive pests we now have to control on an ongoing basis, whereas others have been successfully eradicated.

Why do greenhouses require biosecurity practices specific to covered crop growing?

The greenhouse environment and growing covered crops has its own unique challenges. The risk of disease is greatly increased by the high density of plants and other factors, such as diseases remaining on greenhouse surfaces and becoming a source of re-infection. Attention to greenhouse hygiene practices is critical for pest and disease control.

Building a Biosecurity Plan

It is recommended that all vegetable growing organisations prepare a biosecurity plan specific to their growing operations. A biosecurity plan is a document unique to your production site which details your biosecurity risks and the actions you take to address these risks.

Preparing a biosecurity plan has 6 steps:

1. Review site map
2. Identify biosecurity risk and actions to address
3. Prioritise
4. Communicate expectations
5. Implement
6. Review periodically

This manual is designed to assist a vegetable growing property with step two; the identification of biosecurity risks and actions to address these risks.

To develop a biosecurity plan for your property, use this document alongside "Preparing a Farm Biosecurity Plan" (refer to page 59 for further details on where to find this resource).

Top Tip: to ensure biosecurity practices are integrated into your everyday activity, consider adding biosecurity plans, measures and goals into your business plan.

FUNDAMENTALS OF GREENHOUSE BIOSECURITY MANAGEMENT

Be aware of biosecurity risks

Be familiar with pests and symptoms of diseases that affect your crops so they can be correctly identified, or use a pest identification service.

Display posters that show common pests and diseases to help with identification (industry posters, fact sheets and app's like 'Find-A-Pest' are all useful tools).

Inspect the plants regularly for early detection of pests and diseases, and to identify any problems.

Monitor and record the movement of people, vehicles, plants and materials into the greenhouse.

Ensure staff, contractors and visitors put on clean clothing or single use PPE (personal protective equipment) before entering the greenhouse and dispose of it when leaving the greenhouse.

Keep it clean

Locate the greenhouse within a 'clean' zone, that is quarantined from the 'outside' zone of the rest of the property.

Remove and dispose of crop debris outside the 'clean' zone, away from the greenhouse and preferably in a contained area where it cannot inadvertently be transferred back into the "clean" zone.

Clean and disinfect the greenhouse before planting new crops, and make sure everything you bring into the greenhouse is disinfected.

Keep the greenhouse and surroundings free of known pest host plans to eliminate potential pest reservoirs. If growing beneficial host plants ensure these are correctly identified and their growth managed.

Check your crop

Check that plant seedlings are free from pests and diseases before planting.

Monitor crops regularly.

Keep records

Use records to help with decision-making on using chemical, biological, whole-crop and hot-spot treatments.

Use records to traceback if anything appears unusual.

Track and trend information so you can see if something different is occurring.

Report the unusual

Take photos of any unusual symptoms and put samples in a sealed plastic bag in the freezer.

- Isolate the affected area if possible, and restrict access to prevent spread.
- Immediately report anything unusual to the MPI Pest and Disease Hotline 0800 80 99 66.

SECTION

02

GREENHOUSE MANAGEMENT:

ESTABLISH A ‘CLEAN’ ZONE

Think of biosecurity when designing and laying out a new greenhouse. If you can, have separate entrance and exit doors to each compartment to provide for one-way flow of traffic and equipment.

Creating a ‘clean’ zone around greenhouses and production facilities provides a barrier to reduce pests and diseases entering from the ‘outside’ zone.

The ‘outside’ zone is the remainder of your property and beyond your boundaries. The ‘outside’ zone should also be kept clean and tidy to reduce the risk of pests and diseases entering the ‘clean’ zone and into the greenhouse.

	ACTIONS TO REDUCE RISK	CHECKLIST
'CLEAN' ZONE includes greenhouses, shadehouses, areas surrounding production areas, packing and storage sheds, areas and vehicle tracks between these structures	• Greenhouses and surrounding production areas are situated within a 'clean' zone which is separated from the 'outside' zone of the property.	
	• A five to ten metre wide buffer area is kept clean and maintained around each greenhouse.	
	• A single entrance into the 'clean' zone is used to control the movement of people, vehicles, plants and materials into the greenhouses.	
	• Items are cleaned and disinfected before being moved into the 'clean' zone.	
	• Greenhouses and surroundings are kept free from weeds.	
	• Vehicles in the 'clean' zone are kept free of soil, plant debris and rubbish.	
	• Vehicle tracks and pathways in the 'clean' zone are kept in a tidy condition and free of weeds, plant debris and rubbish.	

	ACTIONS TO REDUCE RISK	CHECKLIST
	• Floors and walls of the sheds are sealed or covered to make cleaning easy, and are cleaned regularly.	
	• Greenhouses have drainage so that puddles or wet areas do not form and become breeding grounds for pests and diseases.	
	• Surface water run-off does not wash into the greenhouses. Ensure suitable drainage is in place and checked regularly especially after weather events.	
'OUTSIDE' ZONE includes your house and driveway and everywhere off-site	• Designated staff and visitor vehicle parking is located in the 'outside' zone and clearly signed.	
	• Vehicles that travel off-site ('outside' zone) are in a clean and tidy state before entering the 'clean' zone, with suitable cleaning equipment made available.	
GREENHOUSE WASTE & RUBBISH Removing waste and rubbish helps reduce pest and disease problems	• Greenhouse crop debris is removed and disposed of immediately after pruning and harvest, at a location outside the 'clean' zone, well away from the greenhouse and in a place where debris and plant juices cannot be transferred back into the clean zone on shoes and clothing.	

	ACTIONS TO REDUCE RISK	CHECKLIST
	• Crop prunings and discarded fruit are placed in a bin so they are enclosed, reducing the risk of re-infection. Ensure that any plant juice run-off from the bin is contained.	
	• Small bins are used for daily pruning and are regularly emptied.	
	• Greenhouse rubbish (disposable gloves, twine) is never left in the greenhouse, the buffer zone, or in the production area.	
	• Rubbish is removed and disposed of outside the 'clean' zone and away from the greenhouses.	
	• Rubbish bins are emptied and cleaned before being moved to another greenhouse. Dedicated bins for each greenhouse is best practice.	
	• Collect all plant waste that shows signs of pests or disease and dispose of it by deep burial or burning, well away from water sources, nursery and production areas.	
	• For cuttings or healthy waste plant material, use a dedicated waste management facility or compost it thoroughly.	

SECTION

03

GREENHOUSE MANAGEMENT:

PEOPLE HYGIENE PRACTICES

Pests, disease-causing organisms and weed seeds can be present on hands, clothing, footwear and personal items of people.

	ACTIONS TO REDUCE RISK	CHECKLIST
ENTRY	• Wash hands thoroughly before entering the greenhouse.	
	• Use a disinfection mat/foot bath at the entry of the greenhouse and ensure plenty of time on it.	
	• Wear clean clothes, or new single use covering (PPE) over clothing including shoe covers, prior to entering the greenhouse and dispose of the coverings/ change clothes after exiting.	
	• Do not wear jewellery or watches in the greenhouse. Glasses should be cleaned with a disinfectant wipe before entry.	
	• Ensure no plant material or fruit is brought into the greenhouse, including tomatoes from elsewhere in a packed lunch.	
	• Only work in one greenhouse section on any one day. If you need to cross over into another section, follow the entry procedures. If you leave and re-enter the greenhouse (e.g., after a break) repeat the procedures that apply when entering the greenhouse.	
	• Personal items such as mobile phones and pens should be regularly disinfected and sealed in a plastic cover.	
EXIT	• When leaving the greenhouse dispose of any clothing coverings, wash hands and disinfect shoes.	

SECTION

04

GREENHOUSE MANAGEMENT:

SANITATION & HYGIENE

Greenhouse cleaning and disinfection needs to be conducted between each production cycle to remove pests and disease that could infect the next crop. Disinfecting is important even if you did not notice any pests or diseases in the previous crop - clean out the greenhouse, then clean it up.

	ACTIONS TO REDUCE RISK	CHECKLIST
CLEAN OUT & CLEAN UP	• At the end of the crop, all plant material - old crop, growing substrate, leaves, stems, dropped fruit, weeds - is removed from the greenhouse.	
	• Greenhouses are always cleaned and disinfected before new crops are planted (refer to the information sheet on the next page).	
	• Tools, containers, and other items are removed from the greenhouse before clean up to ensure the surfaces of the greenhouse can easily be cleaned and disinfected.	
	• Containers and equipment that have been cleaned are not put onto soil or other dirty surfaces.	
	• Tools, containers, shoes and other equipment are also disinfected before being used on a new crop.	
	• The greenhouse is checked to ensure it is clean and free of organic matter (crop residues, algae and used substrate) before being disinfected because organic matter deactivates disinfectants and makes them less effective.	

INFORMATION SHEET:

HEALTH & SAFETY SHOULD BE TAKEN INTO ACCOUNT WHEN PERFORMING GREENHOUSE PROCEDURES

CLEAN OUT THE GREENHOUSE

as soon as cropping has finished

1. Clean the roof before removal of the old crop.
2. Remove old crops and plant material, and dispose of the material away from the greenhouse.
3. Remove and dispose of items that will not be reused - substrate, bags, twine.
4. Remove equipment, tools, plant containers, bins, clips and truss supports, plant hangers, dripper stakes and emitters and other items that will be reused.
5. Sweep the floors and internal structures.

CLEAN UP THE GREENHOUSE

before a new crop is planted

1. Wash the walls, floors, internal structures, and drains with a high-pressure hose and detergent, and rinse with clean water.
2. Clean and disinfect the irrigation (fertigation) system (refer 'Clean up irrigation system' below).
3. Open up the greenhouse and allow the surfaces to dry.
4. Wash walls, floors and internal structures with a chlorine or disinfectant solution (e.g., sodium hyperchloride, hydrogen peroxide, Virkon), and rinse with clean water.
5. Close up the greenhouse but leave the vents slightly open, and leave it to dry.
6. Wash the footbaths and refill with new disinfecting solution.
7. Clean and disinfect equipment, tools, plant containers, bins and other items that will be returned to the greenhouse.
8. Set up the greenhouse for the next crop, taking care that disinfected items do not become contaminated.

CLEAN UP THE IRRIGATION (FERTIGATION) SYSTEM
(Step 2 of Clean up the greenhouse)

1. Remove the sensors for the irrigation system.
2. Wash out the nutrient tanks with a high-pressure hose and detergent or chlorine solution (bleach), and rinse with clean water (NB: nutrients tanks can make ideal breeding grounds).
3. Flush the irrigation lines with an acid cleaning solution (or alternative such as hydrogen peroxide), hold the solution in the lines for a few hours, then rinse with clean water.
4. Soak the dripper stakes and emitters in a suitable cleaning solution, or disinfectant, and rinse with clean water before refitting.
5. **Important:** Test the irrigation system to check that irrigation is distributed evenly throughout the greenhouse.

SECTION

05

GREENHOUSE MANAGEMENT:

LIMITING THE SPREAD OF PESTS & DISEASES

Tools and equipment can carry pests, diseases and weed seeds and may be spread by borrowed or secondhand equipment from other properties.

	ACTIONS TO REDUCE RISK	CHECKLIST
ASSESSING THE PROBLEM	• Inspect the plants regularly, monitoring for pest and diseases to ensure that problems are detected early so they can be acted upon.	
	• Keep records of your crop monitoring even when nothing is found.	
	• Ensure pests and diseases are correctly identified so the right treatment can be used (biosecurity risk pest & disease fact sheets can be obtained from product groups and apps can be used such as 'Find-A-Pest'.)	
	• Ensure your workers know what is 'normal' and the key pests and diseases to look out for.	
	• Increase monitoring frequency during periods of higher risk, such as when conditions are suitable for increased insect activity or a disease outbreak.	
	• Use the inspection and identification information to make decisions on chemical, biological, whole-crop and hot-spot treatments.	

	ACTIONS TO REDUCE RISK	CHECKLIST
PLANT MANAGEMENT Dropping material onto the ground and sweeping it up later can spread disease around the greenhouse. Some diseases can develop spores on plant debris. Reduce risks by crop rotation, variety selection and root zone separation.	• Use new gloves and newly disinfected tools and equipment for each row.	
	• Prune and train plants using disinfected, clean, sharp blades.	
	• Put pruned plant material directly into a bin and dispose immediately.	
	• Place infected plants in a bag before removing to prevent disease spread in the greenhouse.	
	• New plants are inspected before planting, and regularly checked during growth.	
	• Use crop rotation to prevent a build-up of crop-specific pests and diseases when crops are grown in soil.	

	ACTIONS TO REDUCE RISK	CHECKLIST
	• To break pest and disease cycles, empty the greenhouse of plants for short periods between crops.	
	• For soil-grown crops, use a longer period of time to break pest and disease cycles, especially if fumigation is needed.	
	• Select cultivars or varieties with resistance or tolerance to key pests or diseases.	
	• Consider grafting onto tolerant rootstocks.	
	• Maintain a physical barrier or separation between plants to prevent disease spread.	
	• Ensure water run-off flows directly into a drain and not onto the roots of other plants.	
	• Ensure plant containers are placed above the drainage channels to prevent run-off flowing onto other plants.	

	ACTIONS TO REDUCE RISK	CHECKLIST
AGRICHEMICAL TREATMENTS	• Spot treat isolated disease when needed.	
	• Consider agrichemical resistance carefully when assessing the use of agrichemicals.	
	• Use an agrichemical resistance management plan for effective monitoring and reporting over time.	
	• Refer to your industry product group for information on agrichemicals and residue compliance guidelines (e.g., TomatoesNZ 'Insecticides' and 'Fungicides' posters).	
	• Keep a spray diary of all agrichemcials used and take actions to minimise spray drift.	
BEES	• Know where any bee hives have been prior to bringing to your greenhouse.	
	• Check the health of the bees regularly.	

SECTION

06

GREENHOUSE MANAGEMENT:

QUARANTINE & EXCLUSION

Introducing new plants on to your property can allow unwanted pests, diseases and weeds to enter the production system.

	ACTIONS TO REDUCE RISK	CHECKLIST
PLANTS	• Buy seed and nursery stock from trusted suppliers.	
	• Isolate and check new plants to minimise pests and diseases before planting.	
	• Regularly check newly planted crops for pests and diseases, and treat before they get established. Work with sick or suspect plants last.	
	• Keep greenhouses free of non-crop plants including "pet" plants, pot plants, and seed propagation.	
	• Ensure the irrigation (fertigation) system is set up in a way that prevents plant to plant contact from water run-off.	
SUBSTRATE, PLANT CONTAINERS, SOIL	• Clean, pest and disease-free substrate (new or sterilised) is used for each new crop.	
	• Ensure the growing substrate is suitable and meets the needs for the crop, thereby promoting healthy plant growth and reduce the risk of plant stress and infection.	

	ACTIONS TO REDUCE RISK	CHECKLIST
	• For soil-grown crops, the soil is treated between crops.	
	• When taking samples, make sure all sampled material is double-packed. Disinfect the outside of the packaging.	
CLEAN TOOLS AND EQUIPMENT Dedicated tools (ladders, brooms, trolleys) for use in each greenhouse is best.	• Set up a cleaning station for disinfecting tools before they are taken into the greenhouse.	
	• Clean and disinfect tools and equipment (knives, secateurs, brooms, trolleys, pallets), containers (bins, boxes, tubs, buckets, trays, and picking boxes), and other materials (crop supports) before taking them into the greenhouse.	
	• Disinfect pruning tools regularly during pruning. When they are used in a diseased crop area they are cleaned and disinfected before being taken into a healthy crop area.	
	• Use new crop support twine.	

	ACTIONS TO REDUCE RISK	CHECKLIST
GREENHOUSE STRUCTURES AND SURROUNDINGS	• Minimise the number of entrances to the greenhouses to reduce the risk of pest and disease entry.	
	• Install disinfectant mats or foot baths at every entrance.	
	• If you have insect screens, install double doors (and fan) or a double curtain at entrances to reduce the risk of pest and disease entry.	
	• Keep covering materials such as shade or energy screens clean and well maintained.	
	• For greenhouses with opening walls, install splash skirts to reduce entry of mud, water, and pests that gather close to the ground.	
	• Use trenches, gutters or drains to stop crawling pests entering the greenhouse.	
	• Install insect screens on sides that open, and on roof vents where practical.	

	ACTIONS TO REDUCE RISK	CHECKLIST
WORKER AND VISITOR HYGIENE	• Do a risk assessment with visitors and contractors before they enter the greenhouse. If required provide cleaning equipment, clothing and footcovers.	
	• Restrict visitor access and contact with plants.	
	• Ensure workers have a clean change of clothes or overalls every day for greenhouse work, and clothes or overalls are changed after working in a greenhouse.	
	• Dedicated footwear or disposable shoe covers are worn when entering or working in the greenhouse.	
	• Disposable gloves are worn when working in the greenhouse, and are changed regularly.	

	ACTIONS TO REDUCE RISK	CHECKLIST
	• Have workers stay in only one greenhouse section on any one day. If workers need to cross over into another section, follow the entry procedures. If workers leave and re-enter the greenhouse (e.g., after a break) they should repeat the procedures that apply when entering the greenhouse.	
	• Only use disposable paper tissues and ensure they are disposed of immediately after use, and not put into a pocket.	
	• Ensure workers wash their hands before and after working in a greenhouse, and after they have been on breaks.	
	• Have dedicated tools. Don't share equipment with others.	
	• Provide training and information on good hygiene practices to all staff and regularly remind workers why biosecurity is important at the greenhouse.	

SECTION
07

GREENHOUSE MANAGEMENT:

CULTURAL MANAGEMENT

Ensure growing conditions promote optimal plant health, and that plants are not stressed, to reduce the risk of disease development.

	ACTIONS TO REDUCE RISK	CHECKLIST
MONITOR AND MANAGE GREENHOUSE ENVIRONMENT	• Monitor temperature and humidity in the greenhouse.	
	• Ensure the greenhouse has adequate ventilation and heating.	
	• Manage air flow in the greenhouse to maintain a uniform growing environment and discourage disease.	
NUTRITION	• Provide crops with balanced and appropriate nutrition to maintain healthy growth and reduce plant stress and the risk of infection or attack from pests.	
	• Manage plant nutrition by regularly monitoring the feed and drainage solutions including measuring pH, electrical conductivity, and volumes.	

	ACTIONS TO REDUCE RISK	CHECKLIST
IRRIGATION Many factors influence how much water is needed, including: sunlight, temperature, relative humidity and vapour pressure deficit (VPD), crop age and leaf area, crop type and variety, fruit load, type of substrate, and water quality.	• Test the irrigation (fertigation) system for uniform distribution before new crops are planted (refer to irrigation in 'Clean out/ Clean up' info sheet).	
	• Regularly monitor feed volume and irrigation drainage, ensuring appropriate root zone drainage is maintained.	
PLANTING AND OTHER RISKS	• A change or break in crops, or rotation plan, is used to break pest and disease cycles.	
	• Use resistant or tolerant varieties when feasible.	

SECTION

08

GOVERNMENT AND PRODUCT GROUPS ROLE IN BIOSECURITY

Biosecurity is important to New Zealand and its primary industries. This includes having the right measures in place to prepare, respond to and, if needed, manage pest or disease incursions on an ongoing basis.

Ministry for Primary Industries

The Ministry for Primary Industries (MPI) is the government agency responsible for New Zealand's Biosecurity. The Biosecurity New Zealand department is focused on protecting the country and reducing risks.

Biosecurity New Zealand's focus is on stopping pests and diseases at the border, before they get to New Zealand, and eradicating or managing the impact of those already here. With the help of New Zealanders, they ensure the value of New Zealand's primary industries are maintained.

The role of MPI following an incursion is to lead the response and eradication programme, and to conduct continual surveillance.

Government Industry Agreement for Biosecurity Readiness and Response (GIA)

The Government Industry Agreement for Biosecurity Readiness and Response (GIA) operates as a partnership between primary industry and government to manage pests and diseases that could badly damage New Zealand's primary industries, economy, and environment.

Under GIA, Signatories share the decision-making, responsibilities and costs of preparing for – and responding to – biosecurity incursions. By working in partnership, industry and government can achieve better biosecurity outcomes. The GIA Deed outlines the principles for the partnership and the commitments that each industry organisation makes to the wider biosecurity system and to improve biosecurity capacity and capability in readiness and response.

Product Groups Role in GIA

Each industry organisation negotiates and agrees the priority pests and diseases of most concern to them and agree actions to minimise the risk and impact of an incursion, or prepare for and manage a response in the event than an incursion occurs. Signing a GIA allows these product groups to be formally involved in the decisions for managing their biosecurity risks and during a response in the event of an incursion.

Vegetable groups that have signed a GIA deed are:

- Onions New Zealand Inc.
- Process Vegetables New Zealand Inc.
- Tomatoes NZ Inc.
- Vegetables New Zealand Inc.
- Potatoes New Zealand.

Product Groups Role in Biosecurity

Product groups play a key role in biosecurity by communicating biosecurity risks with grower members, completing biosecurity readiness work either within or over and above their GIA commitment. Biosecurity readiness work includes preparation of resources such as this on-farm biosecurity manual. Product groups also assist during biosecurity responses by suppling Ministry for Primary Industries with information and resources when required to respond to the biosecurity incursion.

Product groups act as a communication channel for growers and those directly effected by biosecurity incursions. This allows information to flow from those impacted by the biosecurity incursion to decision makers and back to the growers.

SECTION

09

CASE STUDIES

CASE STUDIES
Examples of biosecurity incursion

There have been many cases of biosecurity incursions in New Zealand horticulture. Some incursions have resulted in pest eradication, while others have not been eradicated.

These examples highlight the importance of good biosecurity management and being vigilant on your farm. Practising good biosecurity management on your farm reduces the risk of pest or disease establishment and potential spread, that could threaten crop and vegetable production in New Zealand.

Impacts of biosecurity incursions on growers:

- **Increased cost of production:** control and eradication of pest and diseases once found on a property is a costly exercise.
- **Significant loss of yield:** pest and diseases can stunt crop growth or decimate harvestable crop.
- **Loss of sell-able crop:** a pest or disease outbreak could leave a crop unfit for human consumption.
- **Loss of access to markets:** outbreaks of pest and diseases in New Zealand can limit international market access for not only the crop in question but also for potential host crops.
- **Loss of right to grow crops:** in some cases, pest eradication will be attempted by banning the production of crops in a certain area. See the Pea weevil case study as an example.

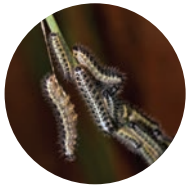
CASE STUDY 1
GREAT WHITE BUTTERFLY ***Pieris brassicae***

Having the support of the public was important for the first successful eradication of an unwanted butterfly pest in the world.

The great white butterfly can threaten brassica crops and New Zealand native cress species. The caterpillars are voracious feeders and can quickly reduce plants to a skeleton, significantly reducing crop yields. Stock will also not graze on infested plants.

Photo: Mary C Legg, #5581696, Bugwood.org

Adults can fly hundreds of kilometres, and lay clusters of 30-100 tiny yellow eggs.



Caterpillars are easy to recognise because they feed together in large groups.

The wingspan of adults is approx. 60mm. Fully-grown caterpillars are 50mm long, pupae are 25mm long.

How did the great white butterfly enter New Zealand?
The great white butterfly was believed to have arrived as pupae on goods arriving at the Port of Nelson.

How long did it take to eradicate the great white butterfly?
It took six years to eradicate the great white butterfly. It was first discovered in Nelson in May 2010. The last butterfly was found in December 2014. Monitoring continued until June 2016 and it was officially declared eradicated in November 2016.

What strategies were used for eradication?
Keeping the public informed and on-side was an important eradication strategy. Department of Conservation rangers had strong support from the public and were given access to private property. The public were asked to report any sightings of the butterfly.

Eradication involved containing and suppressing the main butterfly population to reduce its movement, and other sub-populations and individual butterflies were eliminated to minimise the spread. Individual host plants were also removed and herbicides were used over larger areas of host plants.

Photos: (Middle) Dani Barchana, #5471997, Bugwood.org (Bottom) Hanna Royals, #5559879, Bugwood.org

Is surveillance for great white butterfly still continuing?
Plant and Food Research continues to survey brassica crops in the Nelson-Tasman region.

How much did it cost to eradicate the great white butterfly?
The total cost of eradicating the great white butterfly was almost $5 million. This included a $200,000 contribution from Vegetables New Zealand Inc.

Who was involved in the eradication programme?
The eradication programme was led by the Department of Conservation, and involved the Ministry for Primary Industries, Horticulture New Zealand, AgResearch, and Plant and Food Research.

The involvement of the Nelson community was a very important part of the programme.

"We knew this pest was a potential threat. If it spread, we would have to learn to live with it. We would have to spray more and our costs would go up. My advice would be to consult widely to understand the risk and find out what to do, talk to overseas growers and researchers as well as NZ experts, and don't just accept the first piece of advice that comes along. You never know how things might turn out and who your allies might be. In this case, our industry would not have mounted an eradication on its own and it was only possible because DOC had some rare native brassicas they wanted to protect."

Stuart Davis, vegetable grower, and former Vegetables NZ and VR&I board member.

CASE STUDY 2

PEA WEEVIL ***Bruchus pisorum***

Major sacrifices made by commercial and domestic pea growers in the Wairarapa led to the world's first eradication of pea weevil.

Pea weevil is a threat to fresh peas and pea seed. New Zealand's pea crop is worth $50m domestically, and $73m in exports. With the rise in plant-based food products, the international demand for peas is increasing by 12% annually.

Pea weevil larvae feed on growing peas causing damage which reduces crop yield, seed germination rates, and seed quality. The infested peas become foul and are unfit for human consumption.

The pea weevil relies on the pea (Pisum sativum) for its entire lifecycle. Adult pea weevils overwinter in peas and as the temperature increases they emerge and fly to flowering pea plants where they lay their eggs on the pods. After 1-3 weeks, the larva hatch and burrow into the pea causing damage. Fresh or dried peas can carry pea weevils or their eggs. The weevils can survive up to two years in stored seeds.

Photo: Mariusz Sobieski, #5438869, Bugwood.org

Photo: Natasha Wright, #5203038, Bugwood.org

Adults are brownish-grey in colour, with white flecks, and 4-4.5mm long.

Larvae are white/ cream coloured with a brown head capsule, and 6mm long.

How did the pea weevil enter New Zealand?
Pea weevil was detected in pea seeds in the Wairarapa where ten percent of the national crop is produced.

What strategies were used to eradicate pea weevil?
Removing the pea weevil's food source was considered the best strategy for eradication. A two-year ban on commercial and residential pea growing was put in place. Growing snow peas, sugar snap peas, pea trellis and sprouts was also prohibited.

The movement of pea seeds, pea straw, and pea plantings was restricted, and pea plants were destroyed. Pea seeds and pea straw were also removed from sale in the region.

What long did it take to eradicate pea weevil?
It took four years to eradicate pea weevil. The pest was first discovered in March 2016, and declared eradicated in February 2020. Three years after the ban was implemented, pea weevil was no longer detected.

Two years without detecting pea weevil was needed before it could be declared eradicated, and growing peas could resume.

Is surveillance for pea weevil still continuing?
Surveillance for pea weevil continues in the Wairarapa and Canterbury regions, which are New Zealand's major pea growing areas.

What crops did farmers grow instead of growing peas?
During this time, farmers generally grew more of what they were already growing - alternate crops which included barley, wheat, oats, ryegrass seed, and forage brassica for livestock.

How much did it cost to eradicate the pea weevil?
During the pea growing ban, farmers were offered support and paid ex-gratia payments as compensation for loss of income.

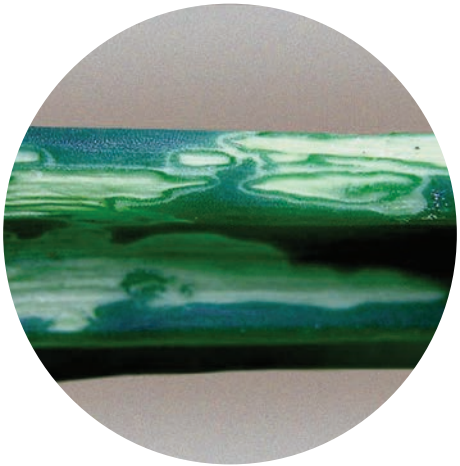
Ongoing surveillance and maintaining traps costs approximately $20,000 to $30,000 annually.

Who was involved in the eradication programme?
The Ministry for Primary Industries led the eradication programme and continues to undertake surveillance. The eradication programme required the cooperation of commercial and residential pea growers, and also seed and garden suppliers.

"Any decision to ban pea growing would really affect my friends, neighbours, industry colleagues, and Wairarapa home gardeners. Being the only person on the governance group commercially growing peas was challenging at times. The key question was would a ban give us a real shot at eradication. Technical advice said it was possible, so the growing ban had my full support. I really pushed for a support package for growers to have alternative crop options and to be compensated so no-one was worse off. We've got some good options now which will make us more resilient. At the end of the day, we did the hard yards over the last four years but it's a really good success story."

Karen Williams, arable grower, grower appointee on Biosecurity New Zealand's Pea Weevil Governance Group

CASE STUDY 3
IRIS YELLOW SPOT VIRUS



The disease, Iris Yellow Spot Virus, is widespread in New Zealand and so far has had little economic impact. The important economic hosts of Iris Yellow Spot Virus are onions, garlic, leek, shallots, and chives.

Iris Yellow Spot Virus is controlled by managing the presence of its vector – onion thrips - limiting the impact of the disease.

The outcome of not controlling the vector and therefore the disease, can lead to the inability of growing crops, increased production costs, and the loss of market access.

Iris Yellow Spot Virus is transmitted by onion thrips (Thrips tabaci). The virus is only acquired by the nymph and is only transmitted by the adult.

The degree of susceptibility varies among cultivars. Iris Yellow Spot Virus affects leaves, roots, bulbs and the whole plant, and can cause the complete loss of seed crops because the flower heads do not develop.

Photo: Ronald D. Gitaitis, #5472705, University of Georgia, Bugwood.org

How was Iris Yellow Spot Virus detected?
Iris Yellow Spot Virus was detected in onions and shallots in a disease survey in the Blenheim area when lesions were seen in brown onion seed plants. It was not found on garlic. The infected plants also had significant thrips damage but there were no IYSV symptoms.

Has Iris Yellow Spot Virus been eradicated?
Iris Yellow Spot Virus has not been eradicated from New Zealand.

How can the impact of Iris Yellow Spot Virus be limited?
The management of onion thrips is important in controlling Iris Yellow Spot Virus as the severity of the disease is related to the presence of the infected thrips.

Photo: Howard F. Schwartz, #5359789, Colorado State University, Bugwood.org

Good farm management practices will reduce the impact of Iris Yellow Spot Virus, and include: maintaining soil fertility and moisture to reduce plant stress; avoiding excessive use of nitrogen fertiliser which attracts onion thrips; removing weed reservoirs and volunteer plants as the virus could overwinter; removing and destroying infected plants; and practicing good hygiene.

Why is it important to manage the Iris Yellow Spot Virus vector?
Managing onion thrips reduces the spread of the disease. It has also been discovered that Iris Yellow Spot Virus can prolong the lifespan of onion thrips by approximately 20%, therefore potentially posing a greater threat if thrips control is inadequate.

Photo: Howard F. Schwartz, #5359793, Colorado State University, Bugwood.org

CASE STUDY 4

POINSETTIA THRIPS ***Echinothrips americanus***

Poinsettia thrips is a pest of greenhouse and ornamental species. In New Zealand, it is not expected to survive outdoors because the climate is cooler.

Poinsettia thrips is a potential vector for viruses, and can impact on Integrated Pest Management (IPM) programmes.

Poinsettia thrips cause damage to host plants by chewing and feeding on the leaves. They target older leaves and woody stems rather than softer stemmed plants such as vegetables. They also feed on flower parts.

Poinsettia thrips cause damage similar to mites and other thrips species. Black spots on infested leaves are faecal droppings of the thrips.

Long distance spread is mostly by the movement of infested plant material or nursery stock.

Poinsettia thrips are small. Adults are about 1.7mm long, can fly and are dark brown/ black in colour with a pale band across the body.

Larvae are light coloured compared to the adults. The nymphs spread by walking and hitchhiking on people and animals.

Where were Poinsettia thrips first discovered in New Zealand?
Poinsettia thrips were first found in an Auckland greenhouse in August 2017.

What strategy was used to eradicate Poinsettia thrips?
The affected greenhouse owner worked with the Ministry for Primary Industries to isolate the area of the greenhouse where the thrips were discovered, and thoroughly inspect all parts of the greenhouse and surrounding area. Trace back to try and find the source; and trace forward of movements from the site were carried out. All growers were asked to check their greenhouse crops and a fact sheet about the thrips was distributed to greenhouse growers and nurseries.

Inspections and treatment of the property was continued until there was sufficient evidence that the thrips had been eradicated.

A survey methodology was developed by entomologists, and industry crop scouts were trained in the survey methodology. The industry crop scouts then worked alongside MPI staff to survey for the presence of the thrips at a sample of several of the traced-forward sites during spring 2017.

Photo: (Bottom) Poinsettia thrips larvae. Image courtesy of Lance Osburne University of Florida.

How long did it take to eradicate Poinsettia thrips?
In May 2018, nine months after the initial discovery, the investigation ended after no further Poinsettia thrips were detected, and the population was declared "not known to be in New Zealand".

Who was involved in the eradication programme?
GIA partners which could have been affected by an incursion of Poinsettia thrips - Tomatoes NZ Inc, Vegetables NZ Inc, as well as Kiwifruit Vine Health - were involved in the response.

This incursion and its investigation is an example of GIA partners working together with the Ministry for Primary Industries in a response and provided useful learnings.

"As a sector, we didn't want a repeat of TPP [tomato potato psyllid]. The growers wouldn't want to go through the same pain again. This wasn't necessarily going to be a serious pest for tomatoes but we didn't want another pest to try and control, or something that may threaten exports. It was also an opportunity to practise a GIA response scenario, working in partnership with MPI."

Helen Barnes, General Manager, TomatoesNZ.

CASE STUDY 5
QUEENSLAND FRUIT FLY *Bactrocera tryoni*

Photo: James Niland, Queensland Fruit Fly - Bactrocera tryoni, Flickr.com

Major problems would be encountered if fruit flies became established in New Zealand – the loss of market access to important overseas markets could occur.

The Queensland fruit fly is the most damaging horticultural pest in its native Australia, costing hundreds of millions of dollars in damage and control each year. New Zealand needs to stay alert to fruit flies because many vegetable and fruit crops would be susceptible.

The Queensland fruit fly causes damage when the larvae feed on the fruit host and cause it to rot. Adult fruit flies lay their eggs below the skin, which hatch into larvae in 2-3 days. The larvae live for 10-31 days and cause considerable damage during this time.

The Queensland fruit fly has a wide climate and host range. It feeds on over 200 different types of fruit and vegetables, though it particularly favours guava, mango, stonefruit, and tomatoes.

Other important species of fruit fly are: Oriental fruit fly (Bactrocera dorsalis), and Mediterranean fruit fly (Ceratitis capitata).

QFF adults are reddish-brown coloured, and have distinct yellow markings and clear wings.

They grow to 6-8 mm long, and are a little larger than a house fly. The larvae grow to 8-11 mm long.

How do fruit flies enter New Zealand?
Larvae-infested fruit which is imported or carried by travellers are the main method of fruit fly entry into New Zealand. Imported fruit needs to meet import health standards and is inspected at the border. To restrict the traveller pathway, MPI's Biosecurity New Zealand has bins placed at international airports so passengers can dispose of any fruit.

How often has fruit fly been detected in New Zealand?
Queensland fruit fly (Bactrocera tryoni) has been detected several times in Auckland and Northland. The most recent discoveries were in 2019 in the Auckland North Shore suburbs of Devonport and Northcote. In the same year, the 'Tongan' fruit fly (Bactrocera facialis) was discovered in Ōtara in South Auckland. A small population was found in Grey Lynn, Auckland, in 2015. Each time, eradication was successful.

Photo: (Top) Pest and Diseases Image Library, #5459416, Bugwood.org (Bottom) Pest and Diseases Image Library, #5459411, Bugwood.org

What surveillance is in place to detect fruit fly?

The Ministry for Primary Industries has had a dedicated fruit fly trapping programme in place since the 1970s. There is a network of over 7,600 traps across the country, with approximately 4,500 traps in the Auckland area. The traps are generally located near airports, seaports, and in important horticultural areas. New Zealand spends $1.6 million annually on fruit fly monitoring.

What happens in a response when fruit fly is detected?

Discovery of a fruit fly triggers a response which is co-ordinated by Biosecurity New Zealand. Controlled areas are declared, and restrictions are placed on the movement of fruit and vegetables in and out of these areas.

Trapping is intensified by installing more traps and placing bait in trees. When no further fruit flies are detected and the scientific requirements are met, only then can restrictions be lifted and successful eradication can be declared.

A large part of a response is keeping the public informed and undertaking measures to ensure their support. These activities include erecting signs around the controlled areas, dropping leaflets into letterboxes, and placing bins in convenient locations for residents to dispose of fruit and vegetable waste.

What are the restrictions placed on the movement of fruit and vegetables?
Any produce being exported that may be a Queensland fruit fly host must meet additional requirements to be eligible for export. Biosecurity New Zealand places an Export Restriction Zone (ERZ) around the area – any produce that could be a host material travelling through an ERZ and destined for export needs to be contained in an insect-proofed environment and additional documentation provided.

Residents living in any controlled areas are prevented from moving produce out of the area, and bins are provided for disposing of fruit and vegetable waste.

How much did it cost for the eradication programme?
The Queensland fruit fly eradication operation on the North Shore of Auckland cost $18 million, with 800 people employed in the trapping activities.

"As growers and exporters, it's not knowing where or when the next fruit fly might turn up that worries us. We could get caught up in the restricted movement zones, causing extra effort and expense. If this pest got away in New Zealand, we'd lose market access and the ability to move tomatoes around the country, and that would impact the whole industry."

Simon Watson, NZ Hothouse (Tomato grower and exporter)

CASE STUDY 6

PSA ***Pseudomonas syringae pv. actinidiae***

Psa is one of the most serious diseases of kiwifruit. Gold kiwifruit in New Zealand were particularly susceptible with 85% of vines removed and destroyed. Today, the kiwifruit industry has largely recovered by planting Psa-resistant varieties.

Kiwifruit is New Zealand's largest horticultural export industry with an export value of over $2.3b (Fresh Facts 2019). At the time of the outbreak in 2010, the loss in exports was estimated to cost the industry $930 million.

Psa is a bacteria that causes canker of green and gold kiwifruit, and kiwiberry. It does not directly affect the fruit but affects plant health and its viability. The disease often causes the vines to die. It first appears as brown leaf-spotting and in severe cases cankers develop on the vines which produce an exudate.

Psa is highly infectious and is spread by spores which are easily spread by heavy rain, strong winds, animals, people, and farm equipment. Harsh winters followed by hot summers are ideal conditions for Psa populations to increase.

Photo: Kiwifruit Vine Health, Psa-V Symptoms Guide

How did Psa enter New Zealand and where was it detected?
Psa is believed to have entered New Zealand in a shipment of pollen from China. It was first found on an orchard in Te Puke in November 2010, but was soon detected on other orchards in the North and South Island.

What strategies were used to eradicate Psa?
The initial intention was to contain and eradicate the disease by removing vines. When this was not possible, the industry worked to minimise damage and identify a pathway for recovery.

The Ministry for Primary Industries responded quickly, and the kiwifruit industry immediately organised a sector-wide response. Kiwifruit Vine Health was established to lead the response, and to re-establish the future of the industry. Kiwifruit Vine Health worked together with ZESPRI, Plant and Food Research, and industry members.

Photo: Kiwifruit Vine Health, Psa-V Symptoms Guide

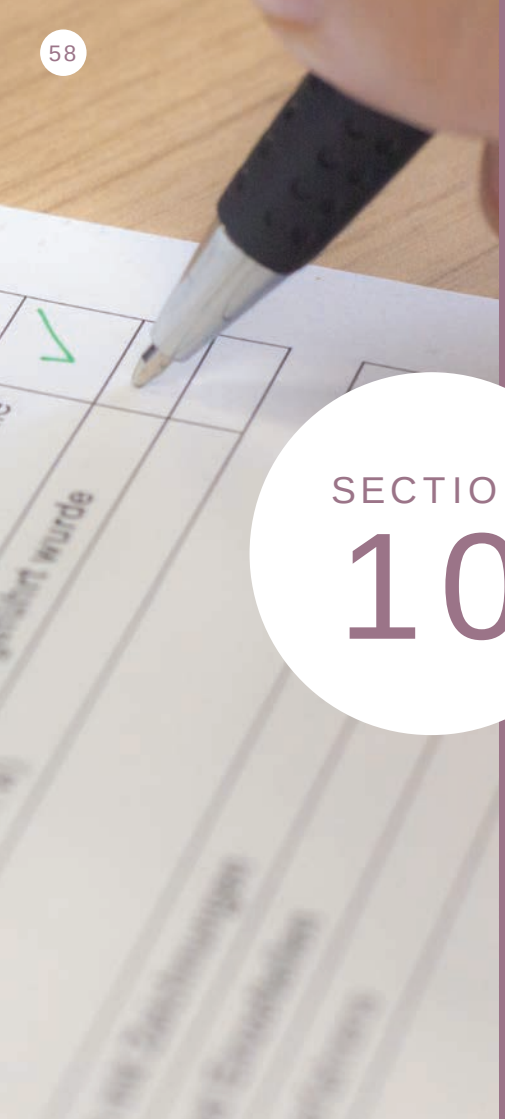
How was the kiwifruit industry re-established?
Significant investments were made in research and development. Psa-resistant cultivars were developed by Plant and Food Research to replace susceptible varieties. Orchard management systems were also developed for the management of Psa-resistant cultivars.

Numerous resources were developed for growers, including risk assessment tools, best practice guidelines, and orchard and environment management tools, so that kiwifruit can be grown successfully in the presence of Psa.

What support was available for growers?
The government agreed to a support package, and invested in Plant and Food Research to enable the research and development-led recovery of the industry. The banks also agreed to limit foreclosures on growers that were forced to remove their vines.

What is the future for the kiwifruit industry?
Today, the kiwifruit industry has more than recovered from the Psa outbreak. The value of exports is now greater than before the outbreak.

New Zealand scientists are also partnering with China to identify new sources of resistance to future-proof the industry.



SECTION

10

ADDITIONAL RESOURCES

ADDITIONAL RESOURCES

Preparing an on farm biosecurity plan (2019): www.hortnz.co.nz/our-work/biosecurity/preparing-an-on-farm-biosecurity-plan/

Minimising soil movement by vehicles off farm (2019): head to www.vri.org.nz/search, search using the term "Washdown Code of Practice"

Vegetables New Zealand Inc biosecurity resources (including signage, factsheets and additional guidance): www.freshvegetables.co.nz/biosecurity/exotic-pests/about-our-biosecurity-alerts/

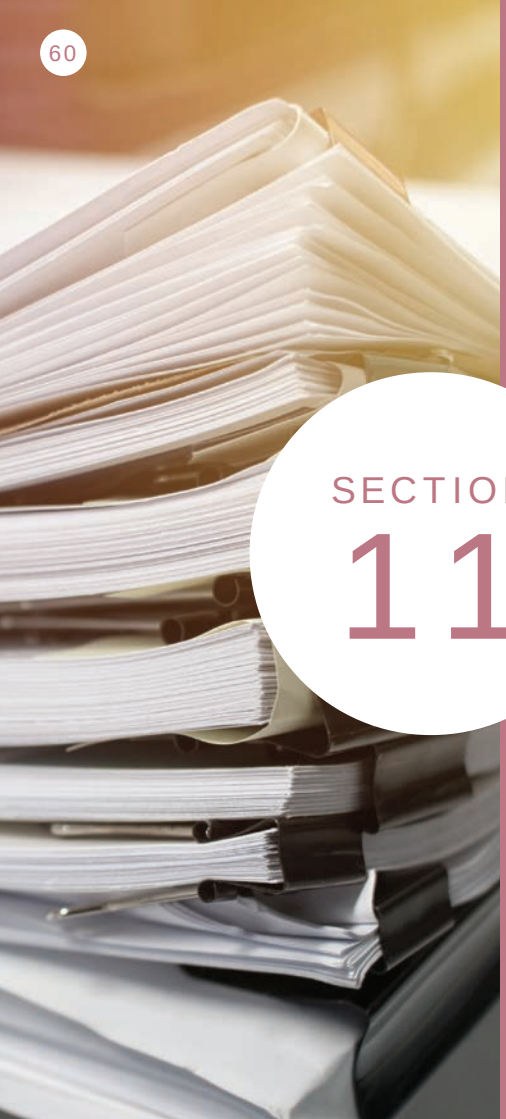
Tomatoes New Zealand – resources for tomato growers (factsheets, biosecurity plan and checklist, agrichemical charts, spray drift information and posters): https://www.tomatoesnz.co.nz/biosecurity/resources-and-fact-sheets/

To review the priority exotic pests for your crops, visit your product group websites:

- Vegetables New Zealand
  https://www.freshvegetables.co.nz/biosecurity/exotic-pests/fact-sheets/
- Tomatoes New Zealand
  www.tomatoesnz.co.nz/biosecurity/

For additional general biosecurity information:

- Biosecurity New Zealand Website
  www.mpi.govt.nz/biosecuritynz
- GIA New Zealand
  www.gia.org.nz



SECTION

11

REFERENCES

REFERENCES

https://www.farmbiosecurity.com.au/managing-greenhouse-pests-and-diseases-to-reduce-costs-and-losses/

https://www.farmbiosecurity.com.au/wp-content/uploads/2019/03/Keep-it-clean-booklet.pdf

https://www.farmbiosecurity.com.au/wp-content/uploads/2019/03/Biosecurity-Manual-for-Onion-Growers.pdf

https://ausveg.com.au/infoveg/infoveg-search/farm-biosecurity-manual-for-the-northern-adelaide-plains-vegetable-growers/

https://ausveg.com.au/app/uploads/2017/05/Biosecurity-R-1.pdf

These are websites, public reports, factsheets and references accessed for the case studies

General pest information
https://www.cabi.org/cpc/

Great white butterfly eradication annual reports
https://www.doc.govt.nz/about-us/science-publications/conservation-publications/threats-and-impacts/animal-pests/pieris-brassicae-great-white-butterfly-eradication-annual-report/

Poinsettia thrips factsheets (Plant Health Australia and Kiwifruit Vine Health)
https://www.planthealthaustralia.com.au/wp-content/uploads/2013/03/Poinsettia-thrips-FS.pdf
https://www.kvh.org.nz/vdb/document/103609

Pea weevil factsheets (South Australian Research and Development Institute (SARDI) and MPI)
https://www.pir.sa.gov.au/__data/assets/pdf_file/0004/285520/Pea_Weevil_Fact_Sheet.pdf
https://www.mpi.govt.nz/protection-and-response/responding/alerts/pea-weevil/

Iris Yellow Spot Virus reference
Ward, L.I. et al. (2009). First report of Iris yellow spot virus on Allium cepa in New Zealand. Plant Pathology 58, 406. Doi: 10.1111/j.1365-3059.2008.01971.x

PSA reference
https://www.kvh.org.nz/vdb/document/870

NOTES

VEGETABLE GROWERS' ON-FARM BIOSECURITY MANUAL

GUIDE FOR COVERED CROPS – PUBLISHED 2020

For additional copies of this resource or additional biosecurity information, please get in touch with your representative product group.