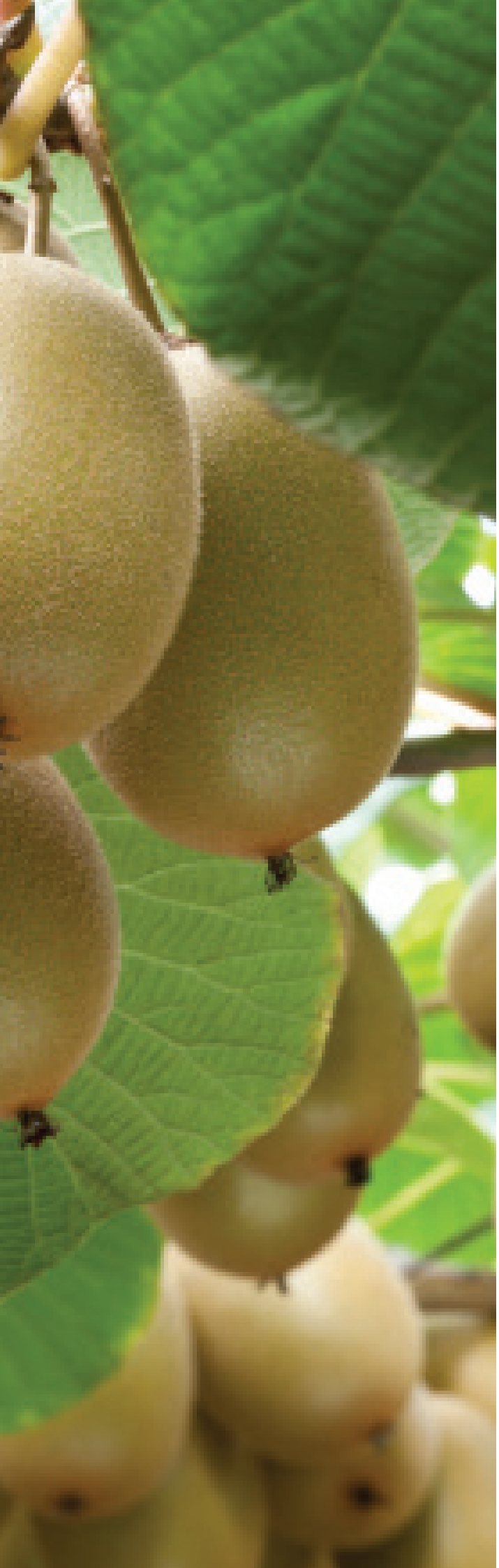
Kiwi protection through Diversity:

Science activities to support the use of SOPI in schools

Ministry for Primary Industries
Manatū Ahu Matua



CONTENTS

CONNECTIONS TO THE NEW ZEALAND CURRICULUM

CURRICULUM PRINCIPLES

The principles set out below embody beliefs about what is important and desirable in school curriculum – nationally and locally. They should underpin all school decision making.

> These principles put students at the centre of teaching and learning, asserting that they should experience a curriculum that engages and challenges them, is forward-looking and inclusive, and affirms New Zealand's unique identity.
>
> The New Zealand Curriculum (2007) p. 9

The principles that relate to this resource are:

Community engagement: The curriculum has meaning for students, connects with their wider lives, and engages the support of their families, whānau, and communities.

Coherence: The curriculum offers all students a broad education that makes links within and across learning areas, provides for coherent transitions, and opens up pathways to further learning.

Future focus: The curriculum encourages students to look to the future by exploring such significant future-focused issues as sustainability, citizenship, enterprise, and globalisation.

KEY COMPETENCIES

The New Zealand Curriculum identifies five key competencies:

- thinking
- using language, symbols, and texts
- managing self
- relating to others
- participating and contributing.

> People use the key competencies to live, learn, work, and contribute as active members of their communities. More complex than skills, the competencies draw also on knowledge, attitudes, and values in ways that lead to action. They are not separate or stand-alone. They are the key to learning in every learning area.
>
> The New Zealand Curriculum (2007) p. 12

The following key competencies are relevant to this resource:

Participating and contributing: contributing to class discussion; participating in group activities that involve working collaboratively to examine aspects of biodiversity, roleplaying the consequences of a biosecurity threat in New Zealand.

Thinking: exploring new ideas and making connections to current events related to the kiwifruit industry; analysing the impact of new technologies within the kiwifruit industry; analysing the importance of biodiversity and agrobiodiversity.

Using language, symbols, and texts: recognising symbols and vocabulary related to specific scientific or technological knowledge; presenting a visual display to represent orchard biodiversity.

Relating to others: working constructively as part of a group; recognising different points of view; forming an opinion on an issue related to the kiwifruit industry.

Managing self: working independently on an activity; managing research tasks independently.

ACHIEVEMENT OBJECTIVES

Nature of Science (NOS)

- Understanding about science
- Investigating in science
- Communicating in science
- Participating and contributing.

Living World (LW) – Ecology

Level 4: Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.

Level 5: Investigate the interdependence of living things (including humans) in an ecosystem.

Living World (LW) – Life Processes

Level 4: Recognise that there are life processes common to all living things and that these occur in different ways.

Level 5:

- Identify the key structural features and functions involved in the life processes of plants and animals
- Describe the organisation of life at the cellular level.

KEY UNDERSTANDINGS

- Understand why kiwifruit are such an important food source and hence such a valuable export for New Zealand.
- Develop an awareness of the role kiwifruit can play in improving human health.
- Broaden students' understanding of the genetic structure of living organisms, with particular reference to kiwifruit.
- Broaden students' understanding of the importance of primary industry exports to the New Zealand economy.
- Understand how a biosecurity incursion can affect a region, environmentally, socially, and economically.
- Justify expanding biodiversity and agrobiodiversity in New Zealand's primary industries.
- Develop awareness of the innovation within the New Zealand kiwifruit and wider horticultural industries.

BACKGROUND NOTES FOR TEACHERS

GENETIC DIVERSITY AND BIOSECURITY – vital links for a sustainable kiwifruit industry

For over 100 years the kiwifruit industry in New Zealand has selectively bred cultivars. This process develops plants that have particular characteristics or traits that consumers want. And this is one way the New Zealand kiwifruit industry has become a world leader in the kiwifruit export market.

When farmers plant a single variety of a crop or breed a specific type of animal we call this a monoculture. Monocultures can have some very positive outcomes. The products are consistent, the farmer develops expertise and needs to invest in resources, such as specialist machinery, for one crop only.

However when something goes wrong, such as when a disease breaks out, the effects can be devastating, as the crops lack biodiversity. The grower has no other plants or animals that are not at risk and has nothing the farm can fall back on for income.

While New Zealand grows a variety of plants and animals, individual farms and orchards tend not to have a lot of biodiversity, or genetic diversity. Therefore the prevention and control of disease is of great importance. The majority of New Zealand kiwifruit orchards grow kiwifruit that are genetically similar and are in close proximity to one another. This means if one orchard is affected with a pest or disease, neighbouring orchards will be at risk of the pest or disease spreading to their orchard.

In 2011 a bacterial infection called *Pseudomonas syringae pv. actinidiae* or Psa-V spread throughout North Island kiwifruit orchards. The Psa (later renamed: Psa-V) incursion caused wide-scale vine losses and devastated many kiwifruit orchards. The new Hort 16a Gold cultivar, which was expected to be a winning combination for growers as it had many of the traits that the high-value Asian market was looking for, was particularly affected.

The orchards that had more than one cultivar of kiwifruit were able to react more quickly to the Psa-V incursion than orchards growing only one cultivar. Growers of the new Hort 16a Gold cultivar who cut out their infected vines were given the opportunity to plant a new cultivar, G3 Gold. This cultivar was bred by Plant and Food Research and showed positive signs of resistance to Psa-V.

In 2015/2016 export volumes of gold kiwifruit returned to the pre-2010 levels as the G3 Gold orchards planted after the incursion are reaching maturity and there is better control of the Psa-V disease.

It is estimated that Psa-V disease cost the kiwifruit industry over $400 million dollars in lost revenue and in the costs of controlling the outbreak. It has never been confirmed how Psa-V entered the country, but bacterial diseases are commonly spread through plant material, orchard equipment, or wind and rain. As a result of the outbreak, the Ministry for Primary Industries has actioned tighter border security to better protect our valuable primary industries in the future.

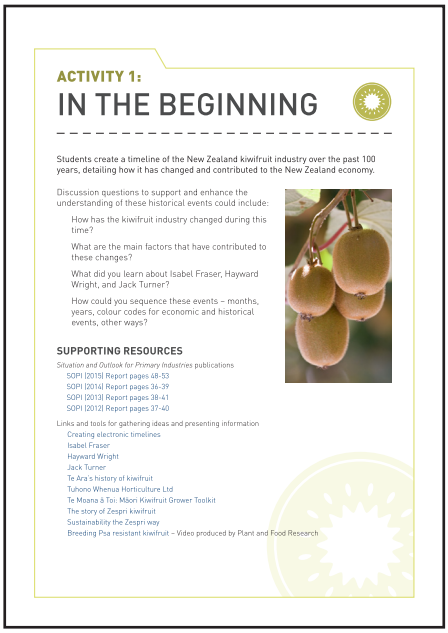
TEACHING AND LEARNING PLAN

How these resources work

These resources are made up of one case study and a set of six activities for each of the learning areas of maths, science, social studies, and technology. The case study has been developed as an introduction to the context of the New Zealand kiwifruit industry and is appropriate for students in all learning areas. This can be shared using a variety of reading approaches (shared, guided, or independently read), depending on what best suits the students you teach.

Each of the following science activities has been developed to be taught over several sessions and the indicative timeframe for each is 1–2 hours.

Once the case study has been shared and discussed, choose the relevant set of subject-specific activities to explore this context in more detail. These activities can be used in any order and with any number of students.



ACTIVITY 1:

IN THE BEGINNING

Students create a timeline of the New Zealand kiwifruit industry over the past 100 years, detailing how it has changed and contributed to the New Zealand economy.

Discussion questions to support and enhance the understanding of these historical events could include:

- How has the kiwifruit industry changed during this time?
- What are the main factors that have contributed to these changes?
- What did you learn about Isabel Fraser, Hayward Wright, and Jack Turner?
- How could you sequence these events – months, years, colour codes for economic and historical events, other ways?

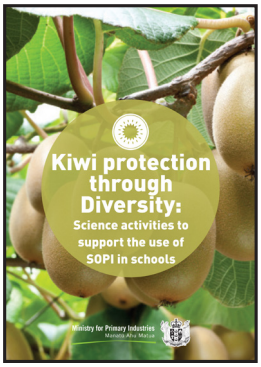
SUPPORTING RESOURCES

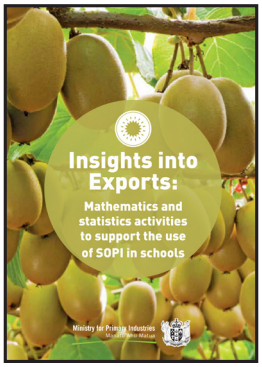
Situation and Outlook for Primary Industries publications

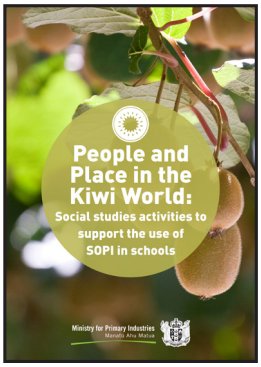
- SOPI (2015) Report pages 48-53
- SOPI (2014) Report pages 36-39
- SOPI (2013) Report pages 38-41
- SOPI (2012) Report pages 37-40

Links and tools for gathering ideas and presenting information

- Creating electronic timelines
- Isabel Fraser
- Hayward Wright
- Jack Turner
- Te Ara's history of kiwifruit
- Tuhono Whenua Horticulture Ltd
- Te Moana ā Toi: Māori Kiwifruit Grower Toolkit
- The story of Zespri kiwifruit
- Sustainability the Zespri way
- Breeding Psa resistant kiwifruit – Video produced by Plant and Food Research







BACKGROUND INFORMATION ABOUT PSA-V DISEASE

The bacterial vine-killing disease Psa-V, (*Pseudomonas syringae pv. actinidiae*), which was confirmed in New Zealand in November 2010, devastated many kiwifruit orchards. The Te Puke district in the Bay of Plenty was the hardest hit. Psa-V spread throughout the Bay of Plenty and to orchards in the Waikato, Coromandel, Auckland, Northland, Hawke's Bay, and Poverty Bay. Nelson was the only kiwifruit-growing region that remained Psa-V free.

As a result of Psa-V, a reduced kiwifruit export crop was harvested from 2012. Gold kiwifruit exports fell significantly due to the removal of Hort16a Gold vines. Gold kiwifruit growers purchased the new Gold 3 license, which is a more Psa-V tolerant cultivar.

Psa-V also affected the production of green kiwifruit, particularly male cultivars. which caused concern about pollination.

Overall, export volumes fell significantly due to Psa-V. The Minister for Primary Industries declared Psa-V a medium-scale biosecurity event on 5 December 2011 and announced a package of support measures to assist North Island kiwifruit growers.

Long-term growth and the success of the kiwifruit industry requires biosecurity risks to be managed throughout the supply chain. Biosecurity responses are in a continual state of improvement and these are noticeable across the entire primary sector in the five years since Psa-V was first confirmed.

Collaboration between the Ministry for Primary Industries and the kiwifruit industry in response to the Psa-V outbreak resulted in the establishment of Kiwifruit Vine Health (KVH).

KVH collaborated with MPI, Zespri, and Plant and Food Research to lead the response to the Psa-V incursion. KVH has now expanded its scope and, as well as identifying and minimising biosecurity risks that could harm the industry, it also acts to strengthen readiness and response plans in the event of future biosecurity breaches.

ACTIVITY 1:

THE KING OF FRUITS

ACHIEVEMENT OBJECTIVES

- NOS: Investigating in science; communicating in science
- LW – Life Processes L4: Recognise that there are life processes common to all living things and that these occur in different ways.

The New Zealand kiwifruit industry is growing at a rapid rate with expected record export volumes and values for the year to June 2016 (SOPI 2016, p. 64-65). Why do other countries want our kiwifruit? Discuss as a class.

Kiwifruit has often been called the king of fruits because of its rich source of vitamin C as well as its other health benefits.

1. Research some of the health benefits of eating kiwifruit. Present your research in graphical form (as a poster, an infographic, or through diagrams).
2. In a group of 3-4 students produce and present a scientific report outlining your results of an investigation into the different food groups present in kiwifruit.

   Use the following tests to determine the presence or absence of the following food groups.

   a. Sugars – Benedict's solution and gentle heat
   b. Protein – equal quantities of Biuret A and Biuret B
   c. Starch – drops of iodine solution.
3. Are there differences between green and gold kiwifruit? How do these results compare with similar tests done on other foods?
4. How do kiwifruit become food? In pairs, create a spider diagram (mind map) to explain the relationship between all of these words. Show the connection between these key words:
   - chlorophyll
   - energy
   - kiwifruit
   - leaves
   - photosynthesis
   - sugars
   - sunlight.

   This can be recorded on paper or digitally, using a programme such as Mindmup, in Google Drawings, or Thinglink.

Extension:

1. Why is vitamin C important for human nutrition?
2. Take part in a global experiment on the vitamin C content in foods: Measuring Vitamin C in food - global experiment - Royal Society of Chemistry.

SUPPORTING RESOURCES

Situation and Outlook for Primary Industries publications

- SOPI (2016) Report pages 62-65
- SOPI (2015) Report pages 48-53
- SOPI (2014) Report pages 36-39
- SOPI (2013) Report pages 38-41
- SOPI (2012) Report pages 37-40

Links and tools for gathering ideas and presenting information

- Science Learning Hub:
  - Kiwifruit has better vitamin C than a pill
  - Vitamin C and the future
  - Current research on vitamin C
  - Enzyme action.
- The Pond – keyword searches – kiwifruit, food tests
- BBC Bitesize – Food tests

ACTIVITY 2:

IT'S WRITTEN IN THEIR GENES

ACHIEVEMENT OBJECTIVES

- NOS: Understanding about science; investigating in science
- LW – Life Processes L5: Describe the organisation of life at the cellular level.

Like all living organisms each kiwifruit cell contains genetic material packaged as nucleic acid molecules called deoxyribonucleic acid (DNA). When scientists develop new species or cultivars such as the Gold3 cultivar, they are selecting genes (or sections of DNA) that produce the characteristics they require.

1. Before starting on the following activities students use a think-pair-share, or bus stop, activity to review their knowledge on cell structure, DNA, chromosomes, and genes.
2. Using this resource on extracting DNA, students extract and observe DNA taken from kiwifruit.
3. Discuss how the DNA extracted by the students related to their expectations of what they thought DNA would look like.
4. Students share research they carry out into one of the following terms:
   - What is a genome?
   - What is gene sequencing?
   - What is known about the kiwifruit genome?

SUPPORTING RESOURCES

Situation and Outlook for Primary Industries publications

- SOPI (2016) Report pages 62-65
- SOPI (2015) Report pages 48-53
- SOPI (2014) Report pages 36-39
- SOPI (2013) Report pages 38-41
- SOPI (2012) Report pages 37-40

Links and tools for gathering ideas and presenting information

- Science Learning Hub - extracting DNA - adapt to use kiwifruit instead of tomato
- Biotechnology learning Hub - DNA extraction
- The Pond - www.pond.co.nz - search for DNA extraction

ACTIVITY 3:

OUT WITH THE OLD AND IN WITH THE GOLD

Developing new cultivars of kiwifruit for disease resistance and improved marketplace demand

ACHIEVEMENT OBJECTIVES

- NOS: Understanding about science; communicating in science
- LW – Life Processes L4: Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.
- Life Processes L5: Describe the organisation of life at the cellular level.

Why did the kiwifruit industry need to look at broadening the number of kiwifruit cultivars grown in New Zealand? Using a SWOT analysis examine the decision-making processes surrounding the introduction of new cultivars of kiwifruit.

Discussion starters to support and enhance the understanding of decision making when developing new cultivars of kiwifruit could include:

1. How is selective breeding different to natural selection? Describe how these terms are related to the science of genetics.
2. Create a table to compare and contrast the main cultivars of kiwifruit grown for export in New Zealand, and their attributes.
3. Discuss the kinds of attributes a kiwifruit breeder might look for in a new cultivar.
4. Discuss the impact of a pathogen such as the Psa-V incursion on the decision of growers to introduce new varieties to their orchards.
5. Discuss the scientific reasons and other considerations a grower may use to decide to grow a new cultivar although their existing vines are healthy and produce good volumes of fruit each year.

Extension:

Genetic engineering (GE) or Genetic Modification (GM) can be highly emotive subjects. Why? Investigate the processes involved in selective breeding and genetic engineering, and then carry out a survey to investigate public opinion related to a proposal that genetic engineering should be introduced into the kiwifruit industry (or any New Zealand primary industry) in order to breed more productive or disease resistant cultivars. What conclusion can you reach?

SUPPORTING RESOURCES

Situation and Outlook for Primary Industries publications

- SOPI (2016) Report pages 62-65
- SOPI (2015) Report pages 48-53
- SOPI (2014) Report pages 36-39
- SOPI (2013) Report pages 38-41
- SOPI (2012) Report pages 37-40

> Gold orchards are now reaching mature production levels following the transition to the Gold3 cultivar due to the bacterial vine-killing disease Psa. Production growth is particularly strong for gold kiwifruit due to higher productivity and land area. Combined with further Gold3 licence releases, the total area producing gold kiwifruit is over 4400 hectares. A further 1600 hectares of Gold3 licence will be made available to growers over the next 4 years.
>
> Competition in the kiwifruit market continues to increase as Chilean kiwifruit export volumes return to normal levels following severe spring frosts in 2013 and 2014. There were large Italian and Greek kiwifruit crops in 2015, which softened EU prices leading into the current Southern Hemisphere selling season. In the medium term, export prices for both green and gold kiwifruit are expected to be stable, aided by strengthening of the USD.
>
> Situation and Outlook for Primary Industries 2016 (p. 64)

Links and tools for gathering ideas and presenting information

- Science Learning Hub
  - Kiwifruit plagued by Psa
  - Teaching Ethics
  - Breeding a New Apple Cultivar
  - Kiwifruit varieties
- The Pond - keyword search - selective breeding, genetic engineering
- Biotechnology Learning Hub
  - Selective Breeding, Cloning and GM
  - Psa-resistant kiwifruit - RNZ audio item
  - Kiwifruit Psa disease genetics - RNZ audio item
  - Frameworks for ethical analysis
- Red apples consumer health

ACTIVITY 4:

PESKY PROBLEMS

Same or different?

ACHIEVEMENT OBJECTIVES

- NOS: Understanding about science, communicating in science, participating and contributing
- LW – Life Processes L4: Recognise that there are life processes common to all living things and that these occur in different ways.

Kiwifruit, like all plants and animals can be attacked by a range of pests and diseases. Many pathogens can be microscopic such as bacteria, viruses or some fungi. Pests can also be larger, such as insects, that can cause damage and even the death of an organism. Our biosecurity industry has developed very strict protocols to minimise the risk to New Zealand's primary industries.

1. Students produce a table to explain the key differences between bacteria, viruses and fungi eg. structure, nutrition, reproduction.
2. Using the resources provided students classify Psa-V disease as one of these categories of pathogenic organisms, justifying their decision.
3. Students prepare a brochure or booklet to outline how kiwifruit industry stakeholders could minimise the impact of Psa-V affecting their kiwifruit crop.
4. Choose one of the biosecurity issues in the table below and list the characteristics that are relevant to this biosecurity risk, for example is it bacterial, fungal, plant or animal, is it parasitic, how quickly it can spread, what it has an effect on, how we can detect it, how we can respond to it.

Information about key biosecurity issues

Foot and mouth disease (FM)	Biosecurity info on FM FM Fact Sheet Foot and Mouth Focus 2014 SOPI pp. 24–25	Myrtle rust (MR)	Biosecurity New Zealand Facts on Myrtle Rust MPI fact sheet on MR
Painted apple moth (PAM)	Biosecurity info on pests and PAM Biosecurity New Zealand PDF Economic impacts of PAM Biosecurity New Zealand PAM Fact Sheet Detailed information about PAM	Fruit fly (FF)	Biosecurity New Zealand Information on FF A map of the Control area for FF Fruit fly alarm in Auckland Stuff 10 May, 2012 Ten fruit flies found in Auckland NZ Herald 2 March, 2015

5. Why is biosecurity such an important issue for New Zealand? How does our biosecurity industry operate?

Extension:

Consider the biosecurity issue that you focussed on in question 3 or 4 above. Imagine that it has successfully invaded New Zealand. Make a list of environmental impacts that could result from this invasion and discuss wider ecosystem implications. What about social and economic consequences?

SUPPORTING RESOURCES

Situation and Outlook for Primary Industries publications

- SOPI (2016) Report pages 62-72
- SOPI (2015) Report pages 48-53
- SOPI (2014) Report pages 24–25
- SOPI (2014) Report pages 36-39
- SOPI (2013) Report pages 38-41
- SOPI (2012) Report pages 37-40

Links and tools for gathering ideas and presenting information

- Science Learning Hub
  - Kiwifruit plagued by PSA
  - Plant & Food Research and Zespri – Responding to PSA
  - Biosecurity
- Kiwifruit disease Psa explained – New Zealand Herald, Nov. 10, 2010
- Information about Psa-V – Ministry of Primary Industries
- Videos: Symptoms of Psa-V; bacterial growth
- Biotechnology Learning Hub – Biosecurity Threat - Kiwifruit vine disease
- MPI response videos:
  - Changes made in preparing for a biosecurity incursion
  - Evaluating the response
  - Protection and response
  - Future Proofing Biosecurity
  - How have MPI responded to the Psa-V disease?

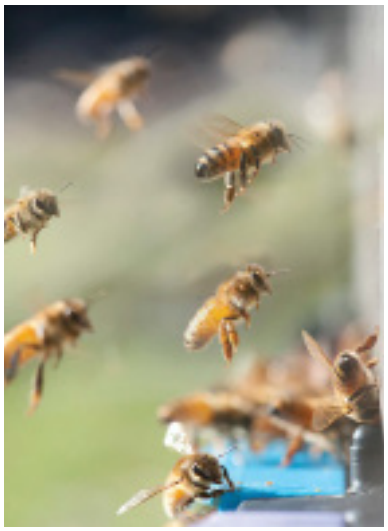
ACTIVITY 5:

TO BEE OR NOT TO BEE

Examining the pollination methods in kiwifruit orchards

ACHIEVEMENT OBJECTIVES

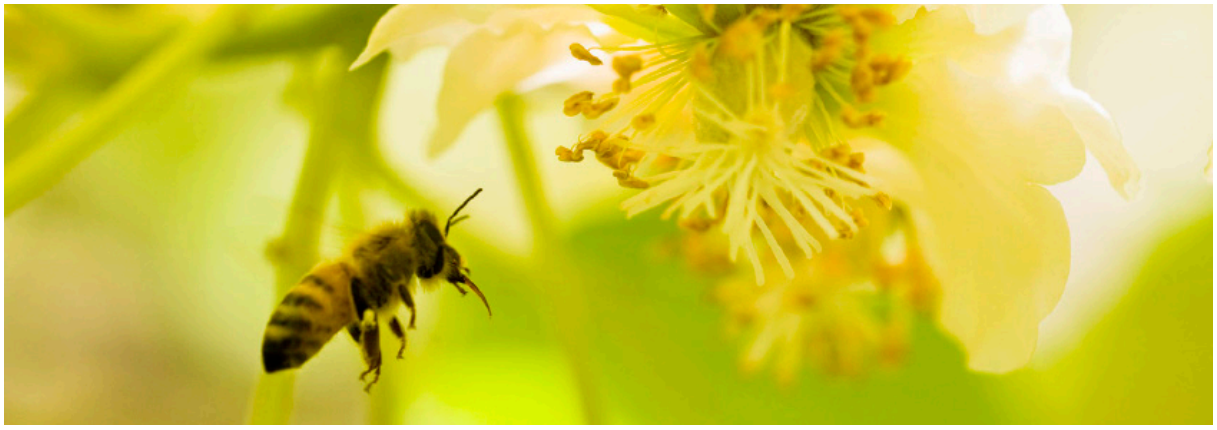
- NOS: Understanding about science; investigating in science; communicating in science
- LW – Ecology L5: Investigate the interdependence of living things (including humans) in an ecosystem.
- LW – Life Processes L5: Identify the key structural features and functions involved in the life processes of plants and animals.



Using a PMI chart to evaluate the issues associated with the process of pollination on a kiwifruit orchard, students create a poster to show how artificial pollination plays a part in the kiwifruit industry.

Discussion starters to support and enhance the development of students' understanding of artificial pollination could include:

1. Students produce a poster (or another form of graphic display) to show the lifecycle of a kiwifruit plant. Include the following keywords: FERTILISATION, FLOWERS, FRUIT, GAMETES, GERMINATION, MATURE PLANT, POLLINATION, SEEDS, SEXUAL REPRODUCTION.
2. Students draw their own diagrams to compare and contrast the structure of a typical flower with that of kiwifruit flowers. How are they the same, how are they different?
3. Look through the pollen processing section of the Science Learning Hub website to extend their understanding.
4. Reading Kiwifruit pollination problems and discussing their findings. How is kiwifruit pollination different to the pollination of other fruit?
5. How do scientists decide which pollen to produce for breeding?
6. Bees are key pollinators for many plants. However the kiwifruit industry is no longer totally reliant on bees to pollinate fruit. Write a report that could be used in a newspaper to explain why this change has come about, and how the kiwifruit industry has tried to find other solutions to the bee problem.



Extension:

Using the Bay of Plenty Regional Council article Many hands needed to control wild kiwifruit as an example of negative aspects of agrobiodiversity, students discuss why natural agrobiodiversity is not always considered to be a positive choice.

SUPPORTING RESOURCES

Situation and Outlook for Primary Industries publications

- SOPI (2016) Report pages 62-65
- SOPI (2015) Report pages 48-53
- SOPI (2014) Report pages 36-39
- SOPI (2013) Report pages 38-41
- SOPI (2012) Report pages 37-40

Links and tools for gathering ideas and presenting information

- Science Learning Hub
  - Plant Pollination
  - Pollination – introduction
  - Pollination and Fertilisation
  - Pollinating Kiwifruit
  - Investigating pollen processing using evidence – activity
  - Artificial Pollination – video and transcript
  - RoboBee – video and transcript
- Ministry for the Environment – About biodiversity in New Zealand

ACTIVITY 6:
DIVERSIFY OR DIE

ACHIEVEMENT OBJECTIVES

- NOS: understanding about science; communicating in science; participating and contributing
- LW – Ecology L4: Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.
- L5: Investigate the interdependence of living things (including humans) in an ecosystem.

Students work in groups to share their ideas about the range of ways in which kiwifruit orchards could improve their biodiversity.

Discussion starters to support and enhance understanding of the importance of biodiversity and agrobiodiversity could include:

1. Make a list of the different species of kiwifruit and indicate which one(s) the New Zealand kiwifruit industry is dependent on.
2. Brainstorm a range of different food chains that could involve kiwifruit and then use this to construct a food web involving kiwifruit. What impact would there be if one of the trophic levels was affected by a pest such as Psa or varroa mite?
3. Research the terms monoculture and biodiversity. Use these to create a table that looks at the advantages and disadvantages of both forms of agriculture.
4. Using their understanding of the term "biodiversity" from above, students work through the biodiversity activity from the Science Learning Hub to explore this in more detail.
5. Students create a visual values continuum with the following statements at each end.

Stance 1	Stance 2
Diversity in a kiwifruit orchard is essential for the long-term profitability of the orchard.	Sticking with one cultivar of kiwifruit that grows well in your orchard is the best way to grow kiwifruit profitably.

They then record one key statement that supports their stance about diversity on a sticky note and arrange their stickies on the continuum.

6. Using the article Sustainability the Zespri Way as a starter, students record five ways kiwifruit growers can improve biodiversity on their orchards. Students could create a poster for growers to encourage these practices on a kiwifruit orchard.

7. Working in groups, students investigate the terms "agrobiodiversity" and "germplasm" and then create a visual display in a format of their choice showing how the terms biodiversity, agrobiodiversity, and germplasm might be relevant in a kiwifruit orchard.

SUPPORTING RESOURCES

Situation and Outlook for Primary Industries publications

- SOPI (2016) Report pages 62-65
- SOPI (2015) Report pages 48-53
- SOPI (2014) Report pages 36-39
- SOPI (2013) Report pages 38-41
- SOPI (2012) Report pages 37-40

Links and tools for gathering ideas and presenting information

- Landcare Research site on biodiversity
- Food and Agriculture Organisation of the United Nations explanation: What is agrobiodiversity?
- Plant and Food Research: Information on bioprotection http://www.plantandfood.co.nz/page/our-research/bioprotection/
- Image of kiwifruit varieties http://sciencelearn.org.nz/Contexts/Food-Function-and-Structure/Sci-Media/Images/Kiwifruit-varieties
- Ethics thinking tool
- The Pond – keyword search – food webs, biodiversity
- Biotechnology Learning Hub
  - Why have an Apple Germplasm Collection
  - The Germplasm Collection – a Library of Apples
  - Combating Kiwifruit Psa