2021 Kiwifruit Book

A Resource for New Zealand Secondary School Teachers and Growers new to the Kiwifruit Industry

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

Kiwifruit Quick Facts

#1

THERE ARE APPROXIMATELY
2,800
KIWIFRUIT GROWERS IN
NEW ZEALAND

#2

KIWIFRUIT REPRESENTS
38% OF THE TOTAL
HORTICULTURE EXPORT REVENUE

#3

THE WORLDS TOTAL PRODUCTION OF
KIWIFRUIT HAS INCREASED BY
50% DURING THE LAST DECADE

#4

ZESPRI SUNGOLD CONTAINS
MORE THAN THREE TIMES
THE AMOUNT OF VITAMIN C
FOUND IN ORANGES

#5

NEW ZEALAND EXPORTS KIWIFRUIT TO
59 COUNTRIES WITH THE
LARGEST MARKETS BEING
JAPAN, GREATER CHINA, SPAIN,
PORTUGAL, GERMANY, TAIWAN & FRANCE

#6

80% OF KIWIFRUIT
IS GROWN
IN THE BAY OF PLENTY

#7

OVER $20 MILLION A YEAR
IS INVESTED BY THE KIWIFRUIT INDUSTRY
AND NZ GOVERNMENT IN THE
NEW VARIETIES BREEDING PROGRAMME

#8

ZESPRI GLOBAL REVENUE
FORECAST TO REACH
$4.5 BILLION
REVENUE BY 2025

FOREWORD

Welcome to the 2021 edition of the Kiwifruit Book. This book is intended as an open-access, up-to-date resource for new growers and secondary school teachers. The Kiwifruit Book is updated annually and covers all aspects of the industry - from orchard practices and the industry structure, through to relevant data related to international marketing and the exportation of kiwifruit.

2021 saw ongoing global disruption from the pandemic caused by Covid-19. By September 2021 the world has seen 2.25 billion people infected with over 4.55 million deaths. Over time we have watched the virus mutate into new more infectious and deadlier strains. While development of effective vaccines was fast-tracked, it has been a race to produce, distribute and administer those vaccines far enough and fast enough to get ahead of the virus.

The New Zealand Government's ongoing response to the pandemic, including the shutting of borders and movement restrictions, has saved New Zealand from a more lethal experience while creating other challenges. The kiwifruit industry has continued to take its responsibilities as an essential business very seriously. Protocols are in place and strictly adhered to, on-orchard, in post-harvest facilities and in related businesses, to protect our people at work. With the disruption resulting from public health mandated protocols, labour constraints, increased costs, transportation holdups and the overall fear and uncertainty, the 2020-21 season has been demanding to say the least. Despite this, 158 million trays of kiwifruit were successfully picked, packed and shipped to market, with jobs in all those sections of the value chain providing a lifeline for workers.

Zespri believes supply is nowhere near meeting global demand. SunGold license releases - 750 hectares per year from 2018-2021, with a further potential 350-750 ha/year signalled from 2022-26, and the returns made per tray sold, is what is driving the huge growth in the Kiwifruit Industry. Every 750ha of production equates to approximately 10 million trays of fruit. This in turn creates 1000 new seasonal jobs at harvest as orchards and packhouses expand in capacity. This rate of growth is therefore only sustainable if we have people to fill those jobs. Labour and Water are two of the biggest constraints for ongoing growth in the Kiwifruit industry. Read more about what is happening in these spaces in Ch 4 (Science and sustainability) and Ch 8 (Labour).

GoHort, the Horticulture Career Progression Manager network, has expanded in 2021. We now have CPMs in 8 regions, and a dedicated tertiary liaison to help bridge the gap between business and academia. The strength of this team lays in the synergies we gain from being able to adapt ideas that have worked in other regions to our own region's specific needs. Please see Ch 9.1 for more on the role of CPMs in the horticulture industry.

I hope that you enjoy using this book and find it to be a valuable resource. If you would like more information on featured topics in this book or can contribute to the next edition, please contact New Zealand Kiwifruit Growers Incorporated on 0800 232 505.

Di Holloway, Education Co-Ordinator/ Career Progression Manager, NZKGI

CONTRIBUTORS

NZKGI would like to sincerely thank all those that have invested their time into the research and development of information that has contributed to this kiwifruit book. Your input directly or indirectly has been of huge value. Those who have been instrumental to the 2021 Kiwifruit Book include:

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CHAPTER ONE

INDUSTRY OVERVIEW

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CHAPTER ONE
INDUSTRY OVERVIEW

This chapter provides the reader with an historical overview of New Zealand's kiwifruit industry, which explains the major events throughout the past century that shaped the kiwifruit industry into what it is today.

Section 1.7 looks at the current industry structure and the key organisations within, and **Section 1.8** examines New Zealand's unique growing environment and recent performance statistics from the 2020/21 period.

With 2021 impacted by ongoing disruption from the global pandemic, **Section 1.9** records the Kiwifruit Industry's response to Covid-19.

THE SECTION IS DIVIDED AS FOLLOWS

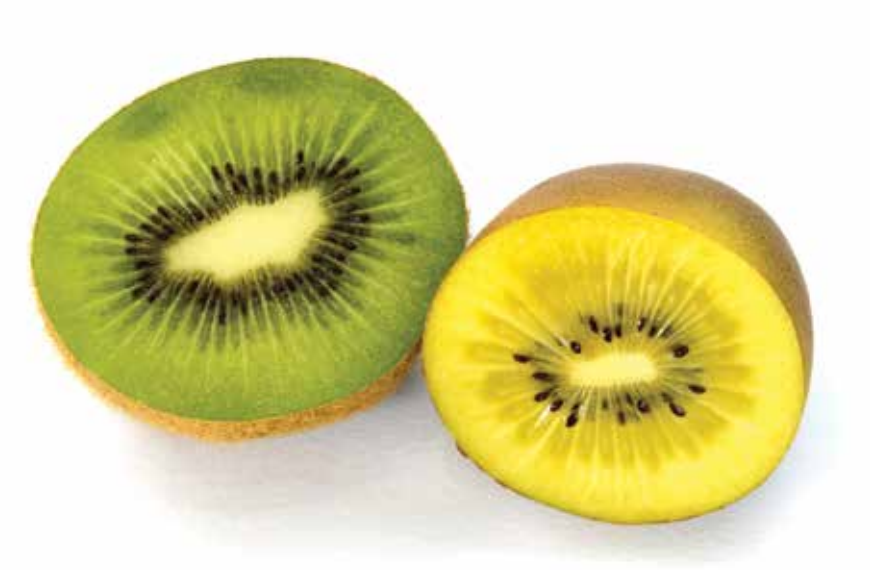
1.1 THE BEGINNINGS

Kiwifruit seeds were first brought into New Zealand from China in 1904 by Isabel Fraser who was a teacher hailing from Whanganui. At the time, kiwifruit was known by its Chinese name Yang Tao and English names Chinese Gooseberry and Monkey Peach. In 1928, New Zealand grower Hayward Wright bred a cultivar of kiwifruit known as 'Hayward'. This is still one of the most widely grown green varieties worldwide. The first Kiwifruit exports were in 1952, to England. The name change to "Kiwifruit" didn't occur until 1959, connecting the fruit to our national bird.

Right:
Isabel Fraser

Far right:
Hayward Wright

> "At the time, kiwifruit was known by its Chinese name Yang Tao and English names Chinese Gooseberry and Monkey Peach."



1.2 1960 – 1980

The kiwifruit industry in New Zealand is youthful in comparison to many other primary industries. Its real commercial beginnings sit in the 1960s. The first industry body, the Kiwifruit Export Promotion Committee, was formed in 1970. This led to the New Zealand Kiwifruit Authority (NZKA), which was established in October 1977.

The structure of NZKA was very different to what exists today with its role being to license exporters, such as Turners and Growers, the New Zealand Fruitgrowers' Federation and Auckland Export and at its peak had up to seven exporters licensed.

As well as licensing, the NZKA co-ordinated packaging and had authority over export grade standards and promotion, but it had no control over sales and marketing activities.

Right & below:
The first commercial exports of kiwifruit showing the packaging and advertisements of the era

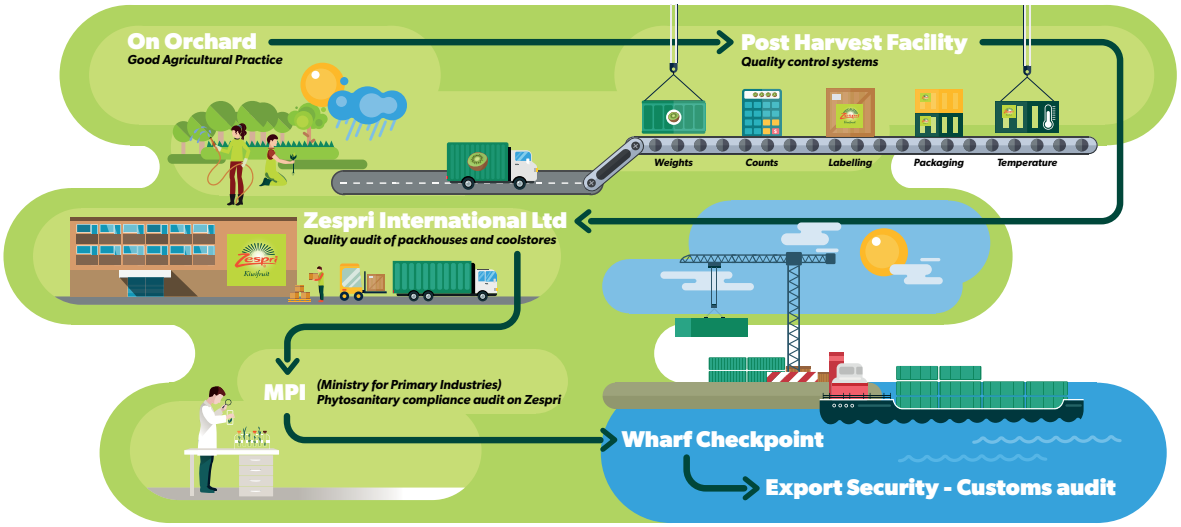
1.3 1980 - 1990

From the mid-1980s production was booming. In 1981 for example, 22,000 tonnes of kiwifruit were exported. By 1987, that had risen to 203,000 tonnes. Over the same period the return to growers per tray had dropped from $7.84 in 1981 to $3.00 in 1987. This resulted in 91 percent of growers making a loss from their kiwifruit operations. A dramatic rise in the New Zealand dollar (NZD) in 1987, followed by inflation reducing policies by the Reserve Bank of New Zealand (RBNZ), led to interest rates reaching their peak at 20.5% in June 1987.

Over-production along with the rise of the NZD made the price of New Zealand kiwifruit expensive in overseas markets and therefore reduced demand. The lack of returns combined with kiwifruit land values falling led to an equity crisis for many growers. This was the turning point that started the debate about the advantages of having one exporter (known today as Single Point of Entry or SPE) over multiple exporters.

In 1987, because of heated debate on the topic, the NZKA engaged a consultant's report. A referendum was then held in September 1988. The industry's set target was to get 80% grower support for the SPE. The fall in export prices and the undercutting between the seven kiwifruit exporters were key arguments in favour of the creation of the SPE. In the end, 84% of growers supported the creation of the Kiwifruit Marketing Board with statutory powers to buy all kiwifruit that was to be exported. The New Zealand Kiwifruit Marketing Board (NZKMB) came into being and its first season of operation was 1989/90. This ended the multi-exporter regime and replaced it with the single desk marketing structure that the kiwifruit industry has today. This foresight has allowed New Zealand kiwifruit growers to collectively develop their industry into a global business with concerted investment in branding, marketing, quality, and research and development.

Below:
The Zespri System showing how the single point of entry simplifies the exportation process



1.4 1990 - 2000

The 1992/93 season was a disaster for the New Zealand kiwifruit industry. New Zealand and international kiwifruit volumes continued to grow, and problems came to a peak during this season as a result of various factors such as bad management and governance. The NZKMB got into serious difficulty with growers being over-paid resulting in massive debt. The NZKMB with strong grower support reacted decisively, and the debt was paid off over the ensuing 18 months.

Because of what had occurred, the industry put in place a three-stage review that incorporated major structural change.

1. **New Zealand Kiwifruit Growers Incorporated** (NZKGI) became operational in July 1994.
2. **Marketing and branding** were reviewed which led to the creation of the Zespri brand, which was launched in the 1996/97 season, and the creation of Zespri as a separate marketing and sales organisation.
3. **Corporatisation, collaborative marketing and the industry's operational structures** were looked at and as a result, a report was presented to NZKGI. A referendum was held, and the structure of the industry altered (in 1996/97) to include: Zespri as a marketing company, a NZKGI Forum, and the NZKMB (which remained in existence).

The positive results of the three-stage review included the formation of the Zespri business, the establishment of collaborative marketing, and a more efficient on-shore operational structure. The three-stage review also incorporated 12-month supply, new varieties and plant breeding.

It was in 1997 that Zespri Gold was launched on a commercial basis and was the first time there was an alternate successful variety to the Hayward. Furthermore, the three-stage review formed the basis of today's kiwifruit industry, and the way in which it operates.

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

Above:
NZKGI became operational in July 1994

1.5 THE EARLY 2000s

April 1, 2000 saw the launch of the Zespri Group Ltd – Zespri was officially corporatised. All growers at that time become shareholders in the Zespri Group Ltd, with the number of shares equivalent to the number of trays produced by growers. The following year saw turmoil within the Apple and Pear Board, which was taken over and subsequently deregulated. The kiwifruit industry structure was different in that only growers could have shares.

In 2001, a change to kiwifruit legislation occurred. A voting cap was introduced to ensure growers retained control of the industry. The maximum number of votes a grower could have was based on production and hence a direct link between production and voting rights was established. No significant further review of the kiwifruit industry has been held until the Kiwifruit Industry Strategy Project (KISP) that was launched in 2014.

1.6 2010 ONWARDS AND THE ESTABLISHMENT OF KISP

In 2014, the Kiwifruit Industry Strategy Project (KISP) was established with the aim of developing a strategy to achieve the industry's long-term market, strategic and financial goals for the benefit of New Zealand's kiwifruit growers.

To help shape the core KISP principles and guidelines, the Industry Advisory Council (IAC) appointed a working group made up from the three corners of the industry structure – growers, postharvest and Zespri. The KISP project began by establishing a broadly agreed set of key principles to guide industry discussion and decision-making when agreeing to a long-term strategy for the New Zealand kiwifruit industry.

These Key Principles Included:

KISP Framework
- The New Zealand kiwifruit industry must act responsibly and ethically on all economic, sustainability, environmental, social and regulatory issues to the benefit of New Zealand kiwifruit growers and the wider New Zealand community.

Single Point of Entry (SPE)
- The Single Point of Entry is retained and enhanced to maximise its performance for New Zealand kiwifruit growers.

Industry Governance
- Given the increasingly competitive international market, Zespri governance must meet world-best practice standards so that it delivers on its purpose.
- Effective leadership and governance of all industry structures must be supported by effective New Zealand kiwifruit grower control, representation and consultation.

Zespri Ownership
- New Zealand kiwifruit growers must own and control Zespri and be the main beneficiaries of Zespri performance.

Marketing
- Zespri's purpose is to be the "best in class" international branded kiwifruit sales and marketing organisation to ensure a sustainable New Zealand kiwifruit industry that maximises New Zealand kiwifruit grower returns.
- Zespri-branded kiwifruit is the best available kiwifruit around the world 12 months of the year for the overall benefit of New Zealand kiwifruit growers.
- The New Zealand kiwifruit industry must have a process to evaluate and implement genuine innovative commercial and marketing ideas, including collaborative marketing, that are aligned to Zespri's global marketing strategy and for the long-term benefit of New Zealand kiwifruit growers.

Supply Chain Effectiveness
- The New Zealand kiwifruit industry must have an efficient, competitive and responsive onshore postharvest sector that is aligned with the industry strategy, offering grower choice that is integrated into an efficient global supply chain. The New Zealand kiwifruit industry must have a world-class global supply chain from orchard to consumer.

Innovation
- To maximise the New Zealand kiwifruit industry's global competitive advantage, the New Zealand kiwifruit industry must continue to develop and implement a world-class and sustainable R&D programme.
- As an integral part of the SPE, the New Zealand kiwifruit industry must have the ability to develop, own, licence, control and maximise the value generated from the world's leading portfolio of kiwifruit Plant Variety Right varieties.

Funding
- Zespri is funded and remunerated appropriately to ensure it can deliver the full scope of its responsibilities.

KISP Principles Established

In a referendum held in March 2015, New Zealand kiwifruit growers turned out in record numbers to vote on the proposed KISP Principles developed by the KISP working group. Two thirds of New Zealand growers representing 80 percent of production voted in the Kiwifruit Industry Strategy Project referendum. 91% of growers who voted supported the ten propositions.

The key results in the referendum were:

- 98% of growers supporting the industry's Single Point of Entry structure
- 92% of growers supporting the implementation of a cap on Zespri share-holding
- 91% of growers supporting a change to how Zespri is funded to maximise returns to New Zealand growers
- 94% of growers supporting changes to their industry representation to ensure they determine grower equity decisions about grower payments

Following the referendum, the KISP group asked the Ministry for Primary Industries to revise the Kiwifruit Regulations to allow implementation of the KISP recommendations. MPI issued a public consultation paper in early 2016 and a revision of the Kiwifruit Regulations was announced in August 2016.

Amendment of Kiwifruit Regulations

In July 2017, an amendment was made to the Kiwifruit Export Regulations which resulted from growers requests in the 2015 KISP Referendum. The revised regulations address three main areas:

- Shareholder alignment;
- Zespri's core business, and;
- The governance and funding of the regulator Kiwifruit New Zealand (KNZ).

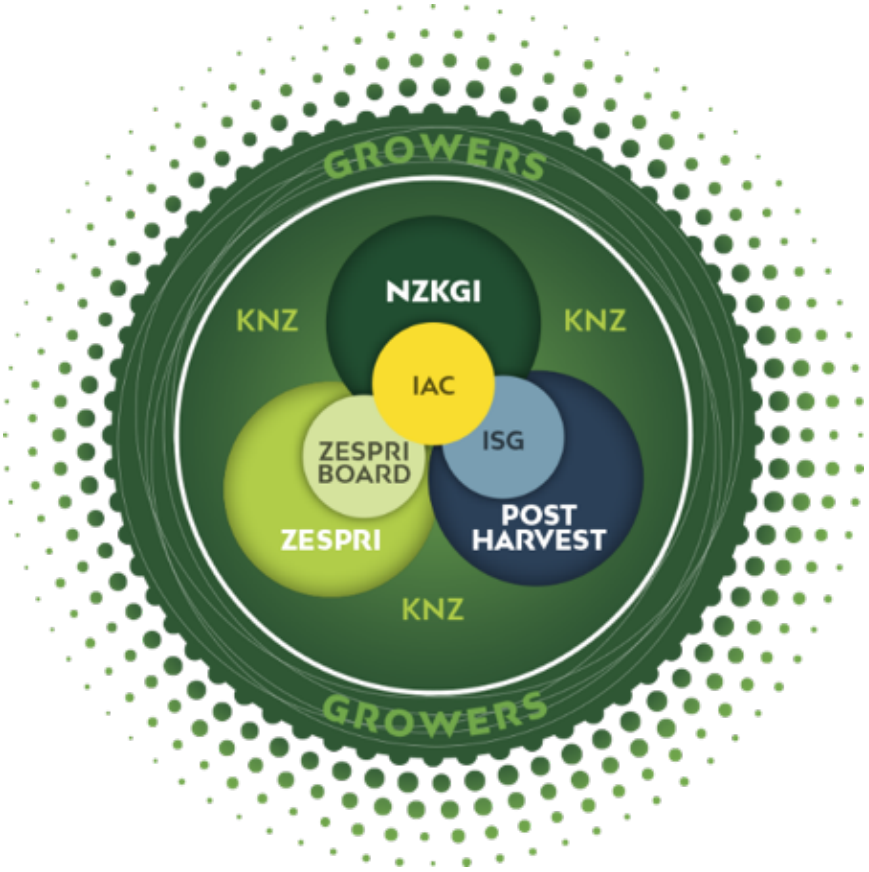
The regulations enable Zespri to make changes to its constitution to allow for greater alignment between Growers and shareholders. The regulations also expand the definition of core business which is expected to provide stability to Zespri as the industry grows, maximizing the wealth of New Zealand kiwifruit Growers. The regulations have made significant changes to the governance and funding of KNZ and while growers no longer had a majority on the KNZ Board, independent expertise was made available. As supported by the KISP referendum, KNZ also have greater flexibility in funding their operations but also enhanced reporting requirements.

Changes for Zespri Shareholders

In March 2018, more than 75% of Zespri Shareholders voted to strengthen grower ownership and control of Zespri. The new constitution introduced dividend restrictions on shareholders who no longer grow kiwifruit and a share cap with a maximum shareholding of four shares for each tray of production. Further, to improve alignment between growers and Zespri, a targeted share issue and buyback programme is planned for late 2018. The share issue and buyback programme will be based on an independent valuation and target a share issue to unshared and under-shared growers, and a buy-back offer to non-producers and over-shared shareholders. More information about KISP can be read on the website. **www.kisp.co.nz**

1.7 KEY ORGANISATIONS

Right:
This diagram shows the different groups in the kiwifruit industry and how they work together to make industry decisions



Zespri International Limited (Zespri)
Zespri is a limited liability company, owned by NZ kiwifruit producers (shareholders), which in addition to its role as the single desk marketer also provides logistics services and research and development management for the kiwifruit industry. The Zespri team is made up of almost 700 employees based in Mount Maunganui and throughout Asia, Europe, and the Americas.

Zespri Board
The Board provides strategic direction for the company and ensure it meets all regulatory requirements. Zespri's eight Board Members bring a wide range of experience, from international marketing and corporate governance to industry knowledge and financial expertise.

Kiwifruit Vine Health (KVH)
KVH is a biosecurity organisation, established in 2010 to lead the response to the Psa incursion. Since 2012, KVH has been the organisation responsible for managing all biosecurity readiness, response, and operations on behalf of the kiwifruit industry. KVH works collaboratively with Growers, Zespri, NZKGI, the postharvest and associated industries, and Government.

New Zealand Kiwifruit Growers Incorporated (NZKGI)
NZKGI was formed following the downturn in the kiwifruit industry in 1993 to give growers their own organisation to develop a secure and stable kiwifruit industry. NZKGI represents kiwifruit growers and protects their political and commercial interests. Key roles include safeguarding the Single Point of Entry (SPE), supporting grower well-being and welfare, consulting with growers on industry initiatives and reporting on Zespri's performance. The NZKGI Forum is made up of 17 elected regional grower reps, 1 Māori Forum rep, and 9 supply entity reps.

Plant & Food Research
Plant & Food Research is a New Zealand-based science company that is a government owned Crown Research Institute. Approximately 100 of the 900 people employed by Plant & Food Research carry out 60% of the kiwifruit industry's research. Kiwifruit has a broad research programme which covers new cultivar development, supply chain and consumer added value. Plant & Food Research have a site in Te Puke that is home to the largest kiwifruit breeding population outside of China.

Māori Kiwifruit Growers Incorporated
The Māori Kiwifruit Growers Forum Incorporated has been created to advocate for the interests of Māori kiwifruit growers and is a partnership between Māori kiwifruit growers, Te Puni Kokiri and Zespri. It aims to improve information dissemination, and to ultimately assist and help improve net returns for Māori growers. The Forum is governed by 9 elected Members who represent the Māori communities involved in the kiwifruit industry.

Kiwifruit New Zealand (KNZ)
The export of New Zealand kiwifruit is regulated through the Kiwifruit Export Regulations 1999. These regulations permit a single marketer to export and market the majority of New Zealand grown kiwifruit outside of Australasia. This position is called the 'Single Point of Entry' (SPE). The Kiwifruit Export Regulations are monitored and enforced by Kiwifruit New Zealand (KNZ). As the kiwifruit industry's regulator, KNZ gives Zespri the mandate to be the vehicle of the SPE. KNZ also have the mandate to allow other exporters to trade New Zealand grown kiwifruit outside of Australasia and do so on a case-by-case basis in collaboration with Zespri. This is dependent on the value those exporters can derive for growers over and above what is achieved by Zespri.

Industry Advisory Council (IAC)
The Industry Advisory Council is specifically concerned with the financial, tax and government related aspects of the kiwifruit industry, for the improvement of grower wealth. IAC manage issues relating to the Supply Contract, decisions relating to the treatment of and payment for fruit and matters with material financial implications for growers. IAC has 5 Grower reps, 5 Zespri reps, and 5 Supply Entity reps.

The Industry Supply Group (ISG)
The Industry Supply Group manages decisions relating to the global supply chain process. Specifically, they monitor quality assurance and rules around labelling, packaging, and the export of kiwifruit. ISG also help in the negotiation of industry wide commercial contracts relating to supply chain activities. ISG has 3 Grower reps, 6 Zespri reps, and 13 Supply Entity reps.

1.7.1 Levy-Funded Organisations

KVH
KVH is funded through two grower levies: a National Pest Management levy for the management of Psa, which from 1 April 2021 is set at 0.1 cents/tray; and a levy for biosecurity readiness and response activities which is set at 1.5 cents/tray. KVH's levy is renewed annually at their AGM.

NZKGI
A grower levy is used to fund the operations of NZKGI. In 2017, NZKGI were given a mandate by kiwifruit growers to work on their behalf for the next six-year kiwifruit levy cycle. 85% of growers participating in the referendum voted to continue the levy. The levy is set at 1.1 cents/tray ($0.0028/kg) and can only be increased by vote at a NZKGI AGM or Special General Meeting.

1.8 NEW ZEALAND'S COMPETITIVE POSITION GLOBALLY

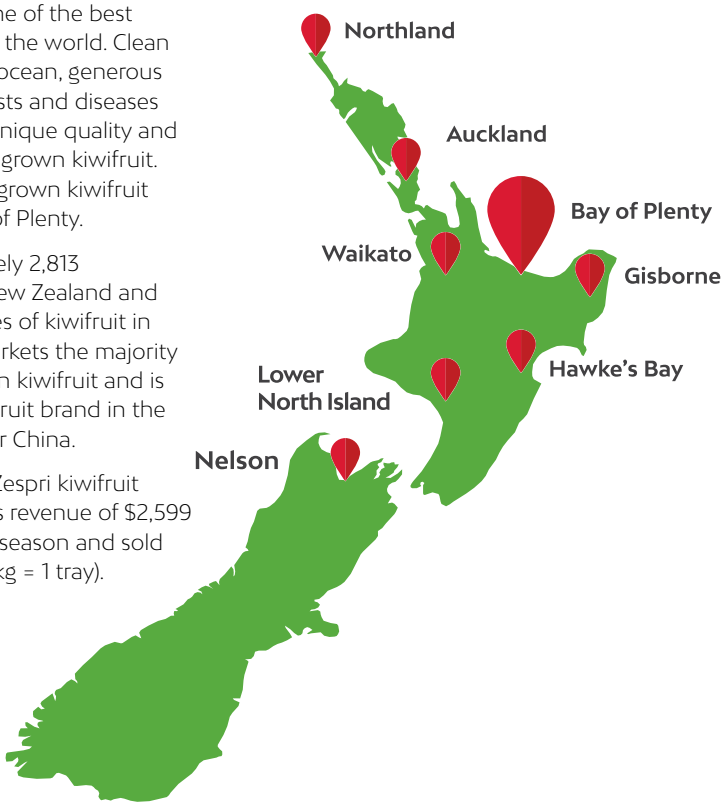
Above:
Birds eye view of kiwifruit and avocado orchards in the Bay of Plenty
(Bevan Jelly, NZ Avocado)

Right:
Regional production of kiwifruit in New Zealand

New Zealand has some of the best growing conditions in the world. Clean air, fertile soils, a cool ocean, generous climate, and fewer pests and diseases all contribute to the unique quality and taste of New Zealand grown kiwifruit. 80% of New Zealand grown kiwifruit comes from the Bay of Plenty.

There are approximately 2,813 kiwifruit growers in New Zealand and around 13,334 hectares of kiwifruit in production. Zespri markets the majority of New Zealand grown kiwifruit and is the most recognised fruit brand in the largest cities in Greater China.

New Zealand grown Zespri kiwifruit generated global sales revenue of $2,599 billion in the 2020/21 season and sold 158 million trays (3.55kg = 1 tray).



The return made by New Zealand kiwifruit export revenue in the 2020 year is significant in comparison to other fruit and vegetables. Kiwifruit was $2.5 billion whilst total horticultural export revenue was $6.6 billion. Kiwifruit represents 38% of the total horticultural export revenue. Although New Zealand grown kiwifruit export returns are large in comparison to other horticultural products, kiwifruit is a small fruit category in a global context. While the world total production of kiwifruit has been increasing, the kiwifruit remains a niche fruit, taking up an estimated 0.22% of the global fruit bowl, which is dominated by apples, oranges, and bananas.

Right:
Number of hectares of kiwifruit produced in each region

Regional production of kiwifruit by hectare in the 2020/2021 year	
Northland	476
Auckland	494
BOP	10,736
Waikato	551
Poverty Bay	353
Hawke's Bay	212
Lower North Island	73
South Island	438

New Zealand kiwifruit growers compete against other kiwifruit growers from other countries and other fruits available in the market at the same time as New Zealand kiwifruit. New Zealand kiwifruit faces competition in all markets from a wide range of fresh fruit and consumer products. Many other producers attempt to capture market space using price while the New Zealand strategy is more about adding value through product taste, quality and consistency, branding, promotional support and reliable supply.

Right:
Picture of fruit stand representing the competition New Zealand faces in the market place

1.9 INDUSTRY RESPONSE TO COVID-19

Late in 2019, worrying reports of a pneumonia caused by an unknown pathogen began to emerge from Wuhan, China. It was identified as being caused by a novel coronavirus SARS-CoV-2 in Jan 2020, when the first cases began appearing outside of China. The disease was eventually named Covid-19, with the WHO declaring the epidemic a global health emergency, and later a pandemic.

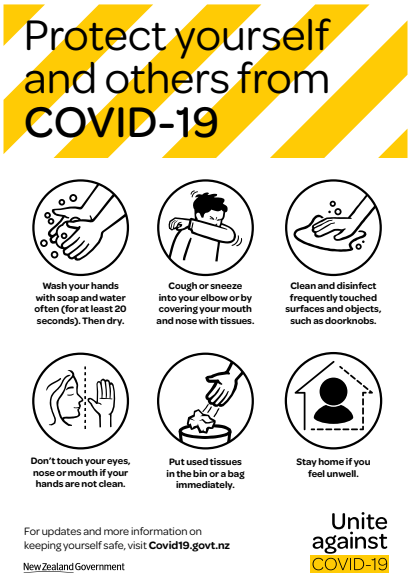
In early February, New Zealand temporarily prevented entry of foreigners who were from, or had travelled through, mainland China. Returning New Zealanders were required to self-isolate for 14 days. On February 28, the first Covid-19 case in New Zealand was reported. The list of countries from which visitors were prevented from entry increased, as did those needing to self-isolate. By March 11, the WHO upgraded the epidemic to a pandemic, by which time NZ had 6 reported cases. Increasing restrictions followed e.g., around the size of group meetings. New Zealanders were urged not to travel overseas, and the borders were closed to most visitors.

On March 21, the alert levels were announced, and New Zealand was placed in Level 2 with 52 confirmed cases. This lifted to Level 3 two days later, and upcoming widespread restrictions on movement were announced to be brought in under Level 4 from 11.59pm on March 25. By this stage there were 155 new and probable cases in the country. Food producers and their essential supply chain businesses were considered essential services and could continue to operate under both level 3 and 4, but within strict conditions.

Under Level 4 restrictions, the Kiwifruit Industry was faced with a huge challenge. Harvest was underway, with an expected increase in fruit volumes coming through. Across the country approximately 23,000 people are employed as seasonal workers in kiwifruit packhouses or on orchards from March until June. Usually around half of these workers would be New Zealanders, 20% would be RSE workers, with the rest non RSE visa holders (e.g., working holiday) or backpackers. With the borders closed this mix would have to change. And all those people would need to be kept safe from the virus.

Businesses with more than 5 people had to register with MPI. Vulnerable workers (those aged over 70 or with underlying health conditions) were asked to stay at home. More stringent pre-employment protocols and site registers were required. As a food industry, Kiwifruit already had hygiene protocols and contract tracing in place. Improvements were made regarding worker hygiene and facilities, with workers required to wash their hands at least 8x per day including on arrival to the site and before and after every break. It was social distancing that caused the greatest upheaval, with the requirement that people be kept 2m apart at all times. Workspaces had to be modified, break times had to be coordinated differently and access to canteens and break spaces reconfigured.

A partnership between Zespri and NZKGI - the Labour Co-ordination centre, was set up to link companies and individuals whose work had been displaced by Covid-19 with kiwifruit businesses that needed workers. From April 6 more than 1000 people registered with the centre, and 200-550 vacant positions were being filled each week.



Right:
Practice good hygiene poster *(source: https://covid19.govt.nz/updates-and-resources/posters/)*

Case study: On-Orchard - Mat Johnson Contracting

Mat and Kris Johnson run their own orchards in Te Puke as well as harvest fruit from 90Ha of client orchards. Despite the kiwifruit industry being declared an essential service there was still a lot of uncertainty in the early days of the pandemic.

"We really didn't know if we could pick our fruit or our clients' fruit" Mat Johnson.

"We had delayed the arrival of our RSE (Recognised Seasonal Employer) scheme workers from Samoa as we wanted to have them here later in the year for pruning. I regret that now because they never got here" Kris Johnson.

The couple feel for their RSE workers, many of whom would have been returning for their third season. The border closure meant those workers missed out on earnings vital for the well-being of themselves, their families, and communities. They were also a loss to the kiwifruit industry.

"They are highly skilled pruners and that's something you can't teach anyone in a day or two, like you can with picking or bud thinning." says Kris.

Anticipating that their staffing needs would change, Kris increased her recruitment efforts, mainly through social media. Other industries were also impacted by the Covid restrictions (particularly Tourism and Hospitality), so there were opportunities to recruit New Zealanders who had lost their jobs.

"We had an Air New Zealand cabin crew member, a vegan baker, black water rafting guides, and of course hospitality workers, a real mix of good people" Kris Johnson.

They co-ordinated picking teams, reducing the size of teams from 18 people to between 12 and 14 per team to meet social distancing rules imposed by Government. They colour-coded their teams, issuing them coloured wristbands and tags on their picking bags to help identify family and housing bubbles.

"Only 3 people could be around bins emptying bags at one time, slowing things down. We were probably 20% down on bin numbers picked during the start of the season" says Mat.

Thankfully, the weather throughout most of April and May was good, meaning pickers could work a longer day (extended from 6-7 hours over the gold period to 9-hour days), and all the available fruit was eventually harvested.

Case study: Packhouse – Trevelyan's

Prewarned of the impending consequences of Covid-19 by friends and colleagues overseas, James Trevelyan had already implemented changes in the packhouse prior to the March lockdown, tripling the company's cleaning team and marking out 1m distancing. However, the Level 4 protocols were still a big step.

"We had two Covid-19 teams, each with four people to monitor the protocols and documentation for the day and night shifts" James Trevelyan.

Staff had their temperature taken each time they arrived at work. Packhouse staff were allocated to specific zones which were the only ones within which they could move. Shift times were staggered, and holes were cut in the sides of the packing shed so staff could maintain a one-way system when moving around. The cafeteria that normally seats 200 people could only hold 40 under the social distancing protocols, so marquees were hired to take the overflow. Special handwashing and drying areas were set up with a screened one-way walk-through system to allow 2m distancing, handling 130 people each shift. Plastic screens were erected to allow separation of staff working closely on the packing lines.

James estimated the additional costs to meet the Covid-19 protocols (including increasing security on site) are in the

region of $300,000 - $500,000, with added reduced productivity, but were worth it for the reassurance it offered staff that they could be safe at work.

“we were able to harvest and pack the fruit, which was very fortunate” James Trevelyan.

The industry was also impacted when the independent laboratory Eurofins was unable to meet the Covid-19 protocols and stopped carrying out maturity sampling and testing. A separate sample is also tested for the presence of chemical residues on the fruit. Successful completion of both these tests leads to the block receiving clearance to pick. Zespri chose to remove the need for dry matter testing from the clearance criteria for the 2020 harvest, opening the process up to allow postharvest operators with their own laboratories to complete the remaining maturity tests. Removal of dry matter testing resulted in changes in the way growers were paid for their fruit (refer to Chapter 6 for more information on Maturity Testing and Grower Payments).

Eventually, through hard work, ingenuity and cooperation, the industry picked, packed and shipped 145.3 million trays of class 1 fruit.

Right:
Screens installed to protect packing staff where the 2m distancing rule could not be met. *(Source: Trevelyan's)*

Right:
Trevelyan's extensive washbasin set-up allowed staff to wash and dry their hands in a one-way system, with 2m distancing maintained at all times. (Source: Trevelyan's)

CHAPTER TWO

ORCHARD DEVELOPMENT

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER TWO
ORCHARD DEVELOPMENT

There are around 13,334 hectares of kiwifruit vines that have been established in New Zealand over the last 100 years. The development of kiwifruit orchards has significantly advanced over that time, particularly in the last 10 years. This chapter identifies important aspects of orchard development.

THE SECTION IS DIVIDED AS FOLLOWS

2.1 GREENFIELD CONVERSION

A greenfield conversion is when land used for farming or another use is converted to a kiwifruit orchard. Prior to any land purchase, consideration must be given to water consent requirements in the area.

The conversion process involves initial capital cost of:

- Site preparation (with possible contouring)
- Establishment of shelter
- Establishment of water supply and reticulation
- Planting of rootstock and grafting kiwifruit or planting pre-grafted kiwifruit plants
- Support structures, initially post and wire then pergola (usually steel ag-beam)
- In some orchards, frost protection (via water or windmill) and overhead hail protection may be included

Once the initial capital work has been completed, vine and orchard maintenance is required to establish the orchard to the producing stage in around three years. Consideration needs to be given to lack of return for a period of 3-5 years before orchards reach maturity and are covering their annual growing costs.

2.2 SITE PREPARATION

Soil quality can be critical for good kiwifruit production. The initial site choice in locating an orchard can save a lot of ongoing work. Well drained loam soils with moderate pH (6-6.5) and organic matter >4% are ideal. Compacted soils, or soils with little drainage and high clay content, and/or low organic matter are generally unsuitable and will require considerable modification before being fit for kiwifruit production. Kiwifruit require relatively high levels of nitrogen in their establishment phase and high levels of potassium once cropping.

Soil Quick facts

Clay soils have high potential fertility but drain slowly and are slow to warm in spring. They are prone to compaction.

Sandy soils drain and warm quickly but require frequent inputs to maintain fertility.

Silt soils have characteristics between clay and sandy soils.

Loams are mixtures of clay, sand and silt that avoid the extremes of each type.

Peat soils are very high in organic matter and have good moisture retention.

Chalky soils are very alkaline and may be light or heavy.

Right:
Knowing the soil texture and structure is important when establishing an orchard

Contouring involves using heavy machinery to modify the surface to even out the bumps and hollows across a block, or to make slopes more workable. Done properly this can improve drainage but there is risk of an uneven distribution of topsoil which can impact on soil structure and fertility later.

2.3 SUPPORT STRUCTURES

Kiwifruit vines need to be trained onto a support structure for commercial cultivation. The most commonly used support structure is the pergola system. Historically, vines have been grown on a T-Bar system which was cheaper to construct and easier to maintain. However, greater yields are achieved on pergola structures and most orchards are now grown using the pergola system.

Right:
A young kiwifruit vine growing on a pergola system
(Shane Max, Zespri OPC)

Right:
Grafted kiwifruit stumps with pergola structures and wires in place ready for training
(Shane Max, Zespri OPC)

Far right:
Kiwifruit growing on a pergola system

Right:
T-Bar grown kiwifruit vines

Far right:
T-Bar to pergola conversion kiwifruit vines
(Shane Max, Zespri OPC)

2.4 SHELTER

It is important to have shelter established before kiwifruit vines are planted. Shelter traditionally referred to vertical wind breaks but more recently overhead cover as well. With climate change, weather patterns are predicted to bring more frequent extreme events e.g., hail. Some of the biggest potential biosecurity risks are incursions by insect species (fruit fly, BMSB). New developments are therefore recommended to factor in fully enclosing new blocks under netting.

Kiwifruit vines do not tolerate wind well. Wind leads to increased physical damage and blowouts of shoots, so young plants and spring canopies are slower to establish. Wind reduction is affected by the height, length and porosity of the shelterbelt, with the original wind speed developing at a distance from the belt of about 40 times the height, and good wind shelter is provided to a distance of 8-10 times the height. Ideally it should be planted at right angles to the prevailing wind. An effective shelterbelt acts as a filter rather than a solid barrier and it should be continuous as the wind will funnel through gaps with increased speed. In an established orchard, reduction in wind speed will raise orchard productivity through improved growth and reduced fruit loss from defects such as wind rub. Gold and Red varieties are more sensitive to this than Green. Blow outs and physical damage on canes can also be entry points for Psa infection.

Right:
Trees planted for natural shelter
(Shane Max, Zespri OPC)

Far right:
Internal shelter helps to keep temperatures up reduce wind and improve the growth of developing vines
(Shane Max, Zespri OPC)

As well as reducing wind speeds, good shelter will increase the temperature in the orchard. Cooler temperatures can cause decreased growth and smaller leaves in young plants. Warmer temperatures in the orchard during flowering can also encourage bee activity and promote normal flower and fruit development. During summer when vines typically require more water, reducing wind speeds reduces evapotranspiration, decreasing how much water the vines require in windier seasons.

Types of Shelter

- Natural shelter from tree shelterbelts is used extensively in New Zealand. Shelterbelts are relatively low cost but take considerable time to establish. Care should be taken to avoid tree species that harbour pests, such as Poplar. Cryptomeria and Casurina spp. are most used. Natural shelter comes with regular maintenance costs, including trimming, mulching and spraying for pests. It also takes up productive land area.
- Artificial windbreaks can be used to increase shelter while not limiting light and still maximising productive land area. Artificial shelter is more expensive to install than natural shelter, but gives an immediate solution, without competing with the vines. While the annual maintenance costs are lower compared with natural shelter, the shelter cloth usually has a ten-year warranty, so the maintenance costs beyond ten years may be much greater than natural shelter. Vertical shelter is commonly 6m high, 4m above the canopy.
- Under vine shelter is a lower cost option where windbreak cloth is run along a row from ground to canopy every 3-5 rows, reducing wind damage and retaining some warmth.
- Overhead shelters cover kiwifruit vines with hail netting on the roof and wind break cloth on the sides. Overhead shelters have an expensive outlay cost, but the financial rewards can be significant. The benefits include:
  - eliminating the impact of a hail event provided the cloth is in good condition
  - a significant reduction in wind speed
  - elimination of wind turbulence
  - reducing leaf wetness and vine damage, minimising the spread of Psa and risk of Psa infection
  - improved pest control.

Overhead shelter has been associated with greater bee mortality and decreased pollination with traditional pollination systems. Ongoing research is revealing new strategies for improving pollination while maintaining hive health.

Table 1. Natural Shelter

Advantages	Disadvantages
• Cheap to establish • Withstands strong winds • Can provide biodiversity	• Utilizes productive land • Competes with vines for light, water and nutrients • Long establishment time • Can harbour pests • High annual maintenance costs

Artificial Shelter

Advantages	Disadvantages
• Instantly established • Get full land utilisation • Easy to maintain • Does not compete for resources with the vine • Can assist pest control	• Expensive • Unattractive • Constrains some orchard activities • May impact bee activity

Right:
The erection of hail netting over an orchard. In this instance the structure also has enclosed sides

> It is important to have shelter established before kiwifruit vines are planted. Good shelter raises orchard yields through improved growth.

Right:
Perimeter artificial shelter *(Shane Max, Zespri OPC)*

Far right:
Internal artificial wind breaks have removed the need for natural shelter and so increasing the productive area *(Shane Max, Zespri OPC)*

2.5 WATER

Historically, access to water has been relatively straight forward, with the early orchards established in the Bay of Plenty where regular rainfall and deep ash soils allowed crops to flourish without irrigation. Climate change, changing land use, increases in plantings and expansion into other regions, are all increasing industry demand for water. At the same time there are increasing constraints on water use, due to fully or over-allocated local water resources, along with societal demands to demonstrate the prudent use of water. Access to water, including water storage, is now a key factor in decision making for orchard development. For more on the industry water strategy see Ch 4.

Research has been completed on Kiwifruit water demands. Kiwifruit vines fulfil their water requirements from available soil moisture, rainfall or irrigation. Vines lose water through evapotranspiration or ET. A measure of their water needs therefore equals the daily ET, measured in millimetres (mm), which depends on the size of the canopy as well as environmental factors (solar radiation, air temperature, humidity and find speed). ET in spring is 2-3mm per day and rises in mid-summer to 4-5mm per day, dropping away through autumn. Usefully 1mm equals one litre per square metre, so in mid-summer kiwifruit vines use 4 to 5 litres of water per square metre of canopy per day.

	Spring	Summer
7 day average ET	3mm	5mm
Canopy extent	24 square metres	24 square metres
Canopy fill	75 percent	100 percent
Daily kiwifruit water use	54 litres	120 litres

Figure 1. Daily vine water use is calculated by multiplying ET by the effective canopy area per vine.

Young developing vines have different water requirements from mature vines due to their smaller canopies and root systems. A new vine may begin the season with only around 1m^2 of canopy compared with 35m^2 for a mature vine. However, because the newly developing leaves are more exposed, and the root ball is small, the volume of water required per vine is greater than the figures above suggest. Soil type is a significant factor in determining how much and how often a block of kiwifruit is watered. Variation of soil types within an orchard requires some precision irrigation so that water is not wasted and vines are not stressed. Soils with a high proportion of pumice will drain more quickly than soils with a high proportion of clay and will require more frequent watering.

Kiwifruit vines that run short of water, especially during phases of rapid growth, will wilt and the leaves will quickly go brown. Kiwifruit vines suffering from drought will produce smaller fruit and excessive drought can reduce the following season's yield. Excessive irrigation, particularly in clay soils, can also be detrimental to the productivity of kiwifruit vines. Kiwifruit roots are sensitive to a lack of air and if the roots remain under water for 24-48 hours it will result in root death from which the vine is slow to recover. Irrigation can also be used as tool to increase fruit size prior to harvest. This is managed with caution by growers because although water increases the fruit size it also reduces the fruit dry matter. Growers are paid using both measures.

Irrigation is generally applied through drippers, micro-jets or micro-sprinklers. Drippers focus water delivery next to or in between the vines while jets and sprinklers will target a wider area. Some systems can be raised or lowered to provide both irrigation and frost protection services. Irrigation methods that wet the canopy can contribute to an increase in Psa disease risk.

Right:
Sprinkler used for irrigation
(*Shane Max, Zespri OPC)*

2.6 FROST PROTECTION

Frost damaged fruit are not edible or saleable and frost damage to vines can negatively impact productivity of kiwifruit vines the following season. Gold and Red varieties are more at risk of spring frost damage as budbreak occurs earlier than in Green. Hayward fruit is more susceptible to autumn frost damage as they are generally harvested later.

Nearly all the horticulturally significant frosts in New Zealand are of the radiation type (rather than advection frosts). Radiation frosts occur on nights with clear skies and little or no wind. As heat is radiated away from the ground and vegetation surfaces, the warmed air rises and is replaced by cold air moving down. This creates an inversion layer. This cold air draws further heat from the plant material. When the cold air is below 0° Celsius a frost occurs, which can result in irreversible damage to the plant tissue.

There are three main types of frost protection: heating, mixing (to disturb the temperature inversion) and radiation barriers. In Kiwifruit, the most widely used methods are sprinkler systems (heating) and wind machines (mixing).

Right:
Severely frost damaged kiwifruit leaves
(*Shane Max, Zespri OPC)*

Far right:
Ice on kiwifruit
(*Shane Max, Zespri OPC)*

Heating

Sprinkler-based frost protection systems are most common and use the heat released when water changes state from a liquid to a solid. Spraying water at an appropriate rate onto a crop under frost conditions causes a layer of ice to slowly develop over the vines. Provided the surface of this ice layer is kept wet, the temperature of the enclosed plant tissue will not drop below about minus half a degree, even though the surrounding air may be at a much lower temperature. This requires a considerable amount of water (approx. 1-3mm/hr/ha or around 300,000L/hr on a 10ha orchard, greater than the flow rate required for irrigation) so well-draining soils are critical.

An older method of frost protection is direct heating by portable heaters and/or frost pots, fueled by combustion (oil, natural gas, LPG, special solid fuel blocks, candles made from wax, compressed wood waste or other similar materials). Effectiveness decreases with distance from the heat source.

Right:
New growth protected from frost damage by a sprinkler system

Mixing

A wind machine or frost fan is essentially a large fan at the top of a 10 or so metre high tower, located in the center of the area to be protected. The 'jet' of air produced by the fan draws the warm air from above the orchard and mixes it into the colder air closer to the ground. Depending on topography and block layout, one fan can protect an area of 4-6 ha. Flying a helicopter at relatively slow speed across the orchard area can also effectively mix the air and provide frost protection. The advantage over wind machines is that the helicopter can concentrate on selected areas if required and fly at greater elevations to provide added mixing capability. There are noise considerations with both methods.

Right:
Windmill used for frost protection
(*Shane Max, Zespri OPC)*

Far right:
Helicopters used for frost protection

Radiation Barriers

The principle of a radiation barrier is to reduce the heat radiated from the vines and soil surface, and hence increase the vine temperatures. This is achieved by intercepting the outgoing radiation by means of frost cloth or similar.

Right:
Overhead shelter
(*Shane Max, Zespri OPC)*

Cold Air Drainage

Since cold has a greater density than warmer air, it settles at the lowest point that it can easily flow to. In kiwifruit orchards, natural or artificial shelter can trap cold air so that it pools, where it can lead to frost damage. Maintaining cold air drainage involves modifying downhill shelter so that cold air can freely drain out of the orchard. This can include removing the lowest metre of foliage from natural shelters so that cold air can flow under, or repositioning shelter to allow for cold air to escape.

For more information: *New Zealand Kiwifruit Journal* Issue 262, August/ September 2020

2.7 ROOTSTOCKS AND GRAFTING

Kiwifruit cultivars that produce desirable fruit do not necessarily have good root systems or resistance to disease. For this reason, commercial kiwifruit plants are not grown from seed but are the result of grafting a good fruit-producing cultivar (termed the scion) onto another cultivar with better root growing capability (the rootstock). The rootstock can also impart its characteristics on to the scion, such as low vigour in vegetative growth.

The two most common rootstocks in kiwifruit are Bruno and Bounty (also called Bounty71). Bruno was a commercial cultivar itself up until the 1970s, when Hayward took over due to its better storing properties. Bruno rootstock is grown from open pollinated seed so retains some level of variability. It is hardy, easy to propagate and resilient – particularly in its resistance to Psa. Bounty is a clonal rootstock i.e. it is propagated through cuttings (cloned) so has very little variation in its attributes. While Bruno is used for both Gold3 and Hayward plants, Bounty is not recommended for Hayward due to its lower vigour and lower Psa resistance. However, when used with Gold3 it increases flowering and slightly reduces vegetative growth. Rootstocks can confer tolerance to climatic and environmental challenges such as waterlogging, drought, extremes in temperature and poor-quality soils. This has allowed for kiwifruit production to spread into more marginal growing areas and may in the future mitigate the impacts of climate change.

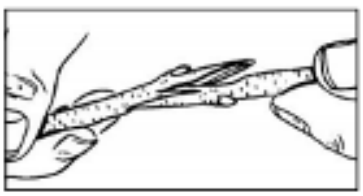
The choice of rootstock can also impact on the timing of the vines development throughout the season (phenology). Gold3 budbreak and flowering can happen a week earlier when grafted onto Bounty compared to Bruno. This has financial implications for those growers whose fruit is early enough to make the first shipment of fruit to market. Bounty is less vigorous than Bruno and requires higher planting densities to speed up full canopy establishment. Growers developing new blocks can purchase rootstock plants and carry out their own grafting or buy pre-grafted plants.

Grafting is also used when there is a need to change cultivars e.g., from Hayward to Gold3, or as occurred post Psa. Grafts can be applied in different places on the vine: notch grafting (side graft); stump grafting; and sucker/rootstock grafting. There are also different techniques: kerf (chainsaw) grafting; cleft grafting; and whip and tongue grafting. In every case the aim is to line up the transport systems of both scion and rootstock so that there is continuous transport of water and nutrients from the roots to the leaves, and carbohydrate from the leaves to the roots. This is easier to achieve before there is extensive sap flow, the pressure of which can be enough to dislodge grafts.

Right:
Successfully grafted kiwifruit vines. Notch grafted (left), Stump grafted (center) and Sucker grafted (right)

Mid-winter is the best time to begin grafting and should be completed by late winter. The grafting success rate declines once sap flow starts. The timing of sap flow depends upon several factors including weather conditions, soil moisture and the chosen rootstock. Sap flow normally lasts six to eight weeks.

Below:
Characteristics of various grafting methods

Kerf (chainsaw) Grafting	Cleft Grafting	Whip & Tongue Grafting
• The whole stump is not split making for easier wound protection/vine health. • Suitable for **stump** and **notch** grafting types. • Can be used on stumps cut very close to the ground. • Section has to be cut to fit the slot. • Rootstock needs to be at least 120mm in diameter (this method is best for larger old vines).	• Suitable for all grafting types **(stump, notch and sucker).** • Difficult to split the stump if cut close to the ground. • Tension of the cleft helps to hold the scion in securely. • Difficult to re-graft failures. • Size of graft wood not a factor.	• Suitable for **sucker/rootstock** grafting. • Size of graft wood not a factor. • Tension of the whip and tongue helps hold the scion wood securely.
		

Right:
Looking down on a kiwifruit stump where the canopy has been cut off and two short pieces of budwood (scion) cleft grafted on

Summer grafting is possible, but sap flow must be carefully managed. Summer grafting is generally not as successful as winter grafting and is usually only used when abnormal conditions exist. For example, if there was a high rate of grafting failure in winter, or high levels of Psa infection in the grafts. The earlier summer grafting is undertaken (November) the better the subsequent growth.

Post grafting care and graft hygiene are of the utmost importance when it comes to ensuring graft success. New shoot growth is vulnerable to damage from birds, leaf-rollers, bronze beetle, slugs, and snails, as well as diseases such as Psa. It is important to keep the base of stump free of weeds and use slug pellets around the base and on top of the stump.

Grafting wounds can be sealed with a wound protectant to prevent water from entering the graft union and will protect the graft against infection.

The links below are two videos showing the grafting methods outlined above.

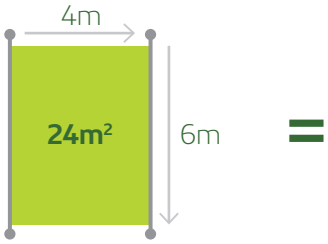
READ MORE HERE:

www.youtube.com/watch?v=4Ikpc7pv41g
www.youtube.com/watch?v=QV4AICjPUIE

2.7.1 Planting Configuration

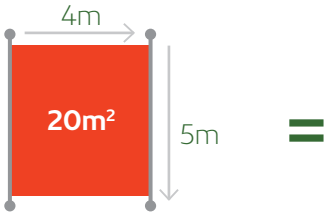
There is no standard bay size or planting configuration in the industry, and there are advantages and disadvantages to consider in both. Ensuring an optimum ratio of male to female plants it crucial, as the closer a female flower is to a male flower the more likely it is to achieve full pollination.

Row spacing around the world ranges from 3-6m, with 3.5-4.5m being the most common in NZ. Post spacing refers to the distance between posts within a row, with a bay being defined by the 4 posts in each corner. Vine spacing refers to the distance between vines within a row, which may or may not be the same as the post spacing. Sometimes vine density is increased to speed up canopy establishment – one vine between posts is "single planting" while two is "double planting". Bay size cannot be changed once the orchard is established but planting density can be altered later by adding or removing plants. More plants with a smaller footprint will have more vigour in terms of vegetative growth. Excess vigour can lead to lower dry matter and will require more labour to control.



LARGER BAYS

- Reduced infrastructure inputs
- Less plants per ha
- Less vigour management
- Slower leader establishment & canopy fill rate



SMALLER BAYS

- Increased infrastructure costs
- 20% more plants
- Higher vigour management
- Faster establishment and time to production

Different kiwifruit cultivars have different ploidy (sets of chromosomes) and not every male cultivar is therefore compatible with every female cultivar. A range of male cultivars have been bred with emphasis on male characteristics such as Psa tolerance, flower numbers, pollen fertility, a long flowering period, attractiveness to bees, and low vigour. Often more than one male cultivar is planted in an orchard to ensure there is cross over of flowering times with the female throughout the whole pollination period. Generally, it is important to use males with the same or higher ploidy than the female (otherwise smaller fruit are produced).

Female Cultivar	Ploidy	Sets of Chromosomes
Red19	Diploid	2x
Hort16A	Diploid	2x
Gold3	Tetraploid	4x
Green 14	Tetraploid	4x
Hayward	Hexaploid	6x

Ploidy	Male Cultivars
2x	Bruce, CK2, CK3, Russell
4x	M33, M91, Earp (079)
6x	Chieftain, King, M36, M43, M56

The ratio of male to female plants, and how they are arranged, has implications on the amount of canopy available for growing fruit. The two main options are Strip Males or Matrix Males (also called female opposing)

F	-	F	-	F	-	F
F	M	F	M	F	M	F
F	-	F	-	F	-	F
F	M	F	M	F	M	F
F	-	F	-	F	-	F
F	M	F	M	F	M	F
F	-	F	-	F	-	F
F	M	F	M	F	M	F
F	-	F	-	F	-	F

Strip Males

Every second row is planted with only Male plants. The male plants are spaced out (alternate bays) to reduce vigour. This is most effective with narrower rows (3-4m). This configuration can be very labour efficient as the males are trained along the leader wire and do not take up much canopy space within the bay. It allows every female plant to be in close proximity to a male.

F	F	F	F	F	F	F
F	M	F	M	F	M	F
F	F	F	F	F	F	F
F	M	F	M	F	M	F
F	F	F	F	F	F	F
F	M	F	M	F	M	F
F	F	F	F	F	F	F
F	M	F	M	F	M	F
F	F	F	F	F	F	F

Matrix Males

Males are interspersed between females in every alternate row, either every second or every third bay. Ideally their footprint is kept small to reduce vigour, and male grafts can be added on to the female vines rather than planting separate plants. More labour is required to keep the opposing females from tangling in the middle of the bay, but it is an effective method in wider rows.

M	-	M	-
F	F	F	F
F	F	F	F
-	M	-	M
F	F	F	F
F	F	F	F
M	-	M	-
F	F	F	F
F	F	F	F
-	M	-	M

East-west Strip Males

This is a hybrid of the two configurations and is often used to increase the male distribution in an established orchard. Male plants are planted by the posts and trained across the pergola/agbeam rather than along the leader wire. This requires more careful management to avoid shading the female leaders.

Right:
Orchard with strip male configuration

2.8 STRINGING

Many orchardists, during the conversion or establishment stages of orchard development employ a management practice called stringing. This is when new growth from the grafted scions is grown up strings to receive maximum sunlight. This encourages apical dominance in the new cane. When the strings are lowered these new canes become the leaders; they switch to a lateral growth habit which fills the canopy area and allows growers to move into production sooner. Once the canopy has developed, some growers choose to train their vines to a low vigour system, while other growers will continue to grow canes up strings every season, effectively refreshing their canopy each year. However, canes growing up strings above the canopy receive far less spray coverage than those trained along the pergola wires, as the canopy acts as a barrier to spray reaching those canes.

Right:
Pergola kiwifruit block set up for growing up strings
(*Shane Max, Zespri OPC)*

Right:
Kiwifruit vines growing up strings

Far right:
Kiwifruit block set up for growing up strings
(*Shane Max, Zespri OPC)*

> "Once the canopy has developed, some growers choose to train their vines to a low vigour system, while other growers will continue to grow canes up strings every season."

2.9 ESTABLISHMENT

Getting healthy plants up and running as quickly as possible has been likened to paying off the mortgage on your house early. High quality planting, grafting and establishment all have a huge ripple effect on the long-term profitability of an orchard for years to come.

Young vines need care to establish well. This can be summarised by the "Three S's":

- **Shelter** – keep them protected from the extremes of the elements
- **Support** – robust and secure structures support good growth
- **Spray** – protect new growth from pests and diseases, and control weeds

CHAPTER THREE

ON-ORCHARD MANAGEMENT PRACTICES

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER THREE
ON-ORCHARD MANAGEMENT PRACTICES

This chapter is diverse, covering a range of orchard management practices. Firstly, the New Zealand kiwifruit growth cycle is explained, and basic orchard management practices are identified. Lastly, an overview of risk management is provided, such as the adverse events that may occur on an orchard.

THE SECTION IS DIVIDED AS FOLLOWS

3.1 NEW ZEALAND KIWIFRUIT GROWTH CYCLE

The growing season for kiwifruit is long: up to 240 days. The New Zealand season begins with vine pruning in winter (June), which immediately follows the previous year's harvest. During the winter months (June to August) the vines lay dormant, allowing growers the opportunity to remove last season's fruiting canes and to select and tie down new canes which form the foundations for new growth.

Springtime (September to November) sees the kiwifruit vines begin to grow again. New shoots appear on the canes along with the first flower buds. When the flowers blossom, bees get to work pollinating the flowers. Pollinated female flowers transform into fruit.

As summer starts (December to February), kiwifruit vines undergo tremendous growth and growers frequently prune the vines to direct growth and manage the canopy (the canes can sometimes reach up to 5-6 meters in length during the growing process). The fruit grow quickly, and crop volume can be estimated. Growers selectively thin kiwifruit to optimise fruit size and taste (generally the less there are, the larger and tastier they grow).

As the weather cools in the New Zealand autumn (March to May) harvest time approaches. Fruit is tested for ripeness and when they pass a certain criteria for quality and grade, the kiwifruit are carefully picked by a huge team of workers. Once the kiwifruit have been picked, they are transported to the packhouse to be packed and stored ready for shipping and export. As the winter approaches, the leaves drop from the vines, signaling the end of another growing year. The vines move towards a dormant state and await the coming of spring.

Kiwifruit vines require sunshine, water, rich free-draining soil, with an ideal soil pH between 5 and 6.8 and winter chilling. To be productive, commercial crops require significant management. The aim is production of a crop of relatively uniform high dry matter fruit of the size preferred by markets.

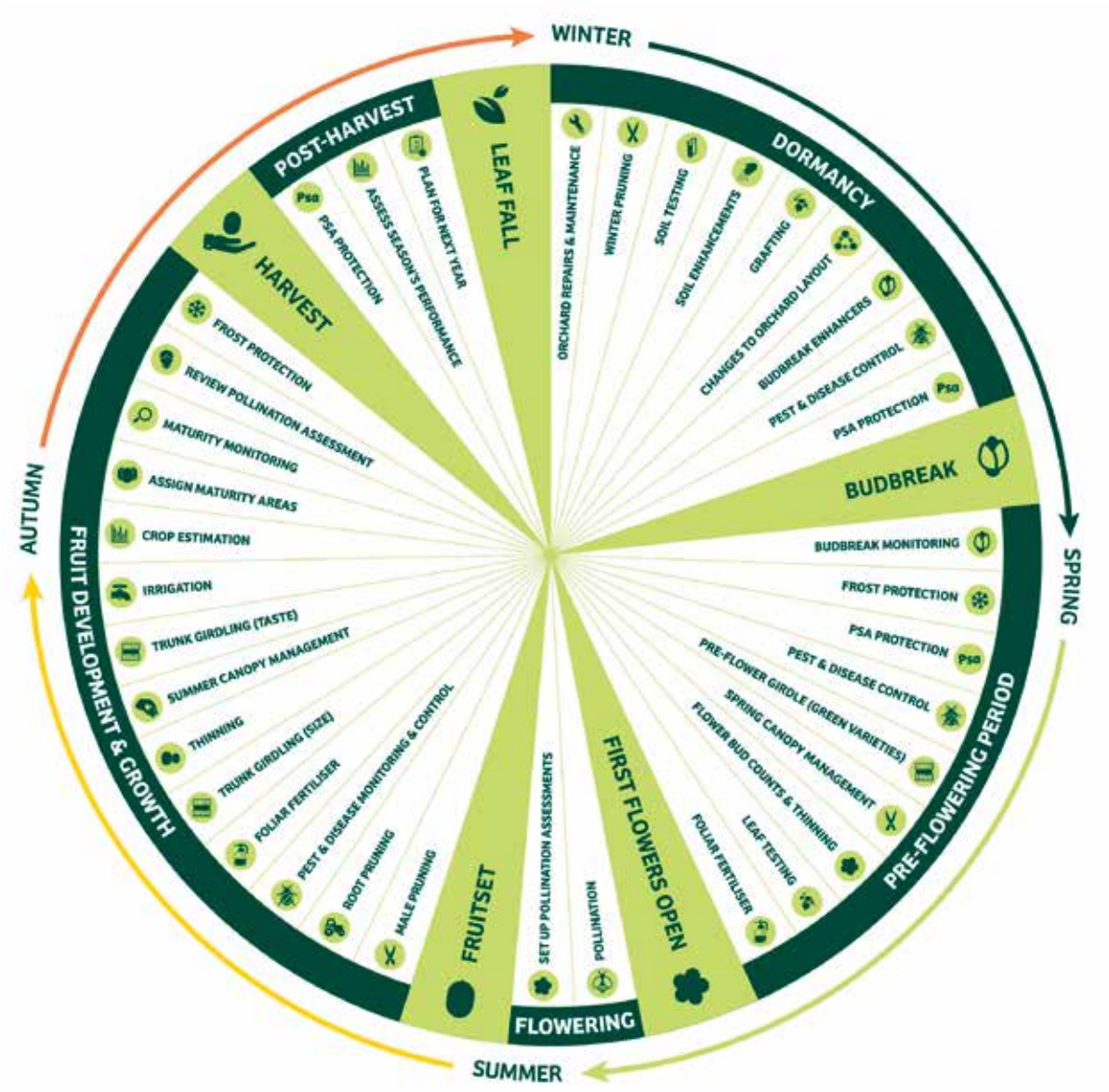
Growers utilise a variety of mechanisms to get sufficient yields including:

- Selection of high-quality replacement cane in spring.
- Pruning – Removing poor quality and unwanted vegetative growth early.
- Budbreak sprays.
- Pollination.
- Bud thinning – Defect buds are removed before they develop into flowers to conserve plant carbohydrates.
- Fruit thinning – Defect fruit are removed as soon as possible to ensure allocation of carbohydrates to high-quality fruit.
- Girdling – Reduces competition for carbohydrates and ensures fruit attain maximum size and dry matter.
- Control of pests and diseases.

Below:
The New Zealand kiwifruit growing cycle showing the vine growth stage and orchard management practices on a seasonal basis

Season	Winter			Spring			Summer				Autumn	
	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRIL	MAY
	Dormant			Budbreak		Flowering	Fruit set		Fruit growth		Leaf fall	
	Winter prune		Budbreak sprays		Bud and flower thinning + pollination	Male prune		Canopy management + thinning +girdling			Harvest	

"As summer starts (December to February), kiwifruit vines undergo tremendous growth and growers frequently prune the vines to direct growth and manage the canopy (the canes can sometimes reach up to 5 - 6 meters in length during the growing process)."



Above:
On-orchard kiwifruit production steps and key management actions

3.2 VINE MANAGEMENT – PRUNING

Successful orchard outcomes are achieved by promoting rapid canopy establishment before flowering, and then limiting canopy growth after flowering to reduce competition for resources with the growing fruit. Pruning is one of the most important aspects of vine management and plays a major role in getting a consistent, quality yield each season. Success depends on good open pruning to prevent the vines becoming dense and tangled. Open pruning allows space for bees during the flowering period, penetration of sprays, air movement around the vines, and enough light throughout the vines to minimise the conditions which favour fungal disease such as Sclerotinia. However, if too much canopy is removed there is a risk of sun damage to fruit as well as reduced photosynthesis.

Open vines provide adequate light needed to ripen the fruit and mature the fruiting canes for the following season. Good light levels are vital for dry matter and sugar level production in the fruit, which ultimately improves taste. This also aids fruit size and enhances the storage life of the fruit. The figure below shows an example of the different types of fruit wood that growers need to manage.

Right:
An even spread of high-quality winter buds

Winter Pruning

Winter pruning can constrain orchard performance if it is not carried out correctly. Winter pruning is done after harvest when vines enter dormancy, preferably after leaf drop so buds are easier to see. The aim is to set up bays with optimal high-quality winter bud numbers on canes that are evenly spaced throughout the canopy. Selection of the best canes to keep, and what to cut out, takes skill and experience. Canes are tied down immediately after pruning.

Even spacing has a great influence on the performance of the canopy the following summer. Consistent canopy density will reduce variation in fruit attributes (e.g., size, dry matter). Even cane and spur spacing results in a consistent summer canopy that produces optimum fruit size and dry matter (climate and summer vine management allowing) and is easy to manage and achieve good spray coverage.

Summer Pruning

Summer pruning involves managing the excess vegetative growth of the vine during the growing season to:

- ensure good light levels on the fruiting canopy
- ensure quality fruiting wood is produced for next year's canopy
- reduce the amount of carbohydrates demanded by the actively growing leaves allowing resources to be redirected to the fruit
- allow good spray coverage

The removal of excess growth also helps to prevent tangles which ultimately saves workload and costs during the following winter prune.

Pruning male vines after flowering/pollination and in summer keeps the vines compact so that they do not shade the female vines or cause tangles. As some male cultivars are more susceptible to diseases such as Psa, keeping a compact vine structure over summer also allows for better spray coverage.

Right:
Grass growing beneath a well-maintained open light canopy
(Shane Max, Zespri OPC)

Far right:
Poorly maintained with low light levels have led to shading and leaf drop
(Shane Max, Zespri OPC)

Right:
Regrowth's and tangles in gold kiwifruit
(Shane Max, Zespri OPC)

Far right:
A non-terminated cane is shown on the left and a terminated cane on the right
(Shane Max, Zespri OPC)

The key to summer pruning is timing. Timing depends on several factors, including but not limited to vine age; orchard environment; climate; canopy vigour; fertiliser use; the layout and structure of the orchard; and the size of the block. These factors will vary between and within orchards.

Key considerations for achieving good results from pruning are:

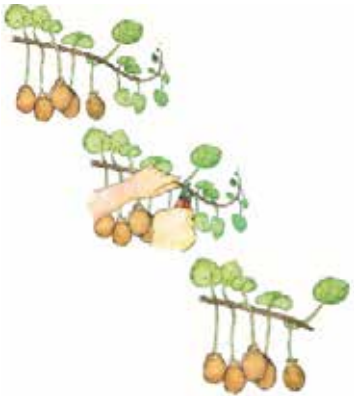
- Tip squeezing non-terminating shoots in the fruiting canopy to approximately four to six leaves past the last flower. The best time to do this is just as the earliest shoots begin to tangle.
- Removing vigorous excess canes, and canes with no fruit (blanks), as they will compete with fruit growth and increase shading.
- Self-terminated shoots do not need to be cut or shortened as these will not continue to grow or cause shading and are potentially the best cane to leave for next year's fruiting wood.
- Late growth (after flowering) should be removed as canes grown before flowering are always more fruitful than late grown canes.
- Shaded cane or spurs need to be removed, as wood that is exposed to sunlight will always produce more flowers and better-quality fruit.
- Canes growing back over the leader need to be removed as they are difficult to tie down and are not optimal for vine structure and growth.

Zero-Leaf Pruning and Tip Squeezing

Both zero-leaf pruning, and tip squeezing are management practices that are used to help maintain optimal light levels and to reduce vegetative vigour.

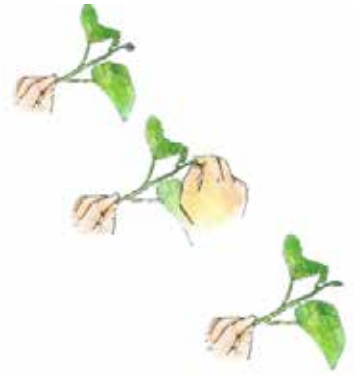
What is Zero-Leaf Pruning?

Zero-leaf pruning involves pruning selected fruiting shoots just above the last (distal) fruit on a lateral so that there are no axillary buds from which secondary re-growth can develop. If this technique is done correctly, the vines are not too vigorous and virtually no re-growth will occur from the zero-leaf pruned shoot. This technique is primarily done to save on pruning costs later (by reducing tangles). However, any pruning cut increases the risk of Psa infection due to creating a soft tissue wound. It can also impact on availability of quality wood for the following season if too many shoots are pruned.



What is Tip Squeezing?

Tip squeezing (or crush tipping) involves damaging the growing tip of actively growing shoots preventing further extension. Unlike straight pruning or removal of the tips, which can stimulate secondary growth from lateral buds, tip squeezing leaves the shoot tip damaged but not broken. If undertaken, tip squeezing is conducted several times (approximately five times dependent on canopy vigour) throughout spring and summer and minimises the need to summer prune.



Right:
A strong shoot about to be zero-leafed

Far right:
An actively growing shoot tip prior to squeezing (left), and the controlled damage of the intact shoot tip following squeezing (right)

3.3 BUDBREAK

Budbreak refers to when the buds on dormant canes open and start growing shoots and then flowers in Spring. Timing and quality of budbreak depends on winter chilling. Winter chilling is measured from the start of May each year (typically measured as the number of hours below 7° Celsius or the average temperature across May, June and July). Timing of budbreak is affected by temperatures up to the start of budbreak, but number of flowers can be affected by temperatures between budbreak and flowering. The colder the winter, the earlier budbreak will begin, and the more king flowers will come from each bud.

There are advantages in having a more uniform budbreak across a production block, as well as maximising the number of quality flowers while minimising the spread in timing of flowering. Several different chemicals can be applied to the vines during dormancy to enhance budbreak, the most frequently used being Hydrogen Cyanamide (marketed under different trade names, the most common being Hi-Cane). These products can make up for reduced winter chilling, allowing for kiwifruit production in warmer parts of the country and in the future with warmer winters.

Timing of application is critical with budbreak enhancers. Hydrogen Cyanamide is most effective when applied 35-25 days before natural budbreak. Determining when that budbreak "day" would occur can be difficult (natural budbreak takes 10-30 days to complete). It will vary by region, but wood quality, cropping history and orchard management can also impact on timing of budburst. Models exist based on mean monthly temperature data from previous years, but it is not an exact science. Gold3 and Red19 have earlier budburst than Hayward.

In October 2021, the Environmental Protection Authority (EPA) reassessed the ongoing use of Hydrogen Cyanamide through public consultation. The outcome of the consultation is not expected to be known until mid-2022. Meanwhile research continues on alternative chemicals to Hydrogen Cyanamide, the effect of different management techniques, and development of future kiwifruit varieties that will be less reliant on budbreak enhancers.

Right:
Stages of bud break.

3.4 POLLINATION

Right:
Male kiwifruit flowers

Far right:
Female kiwifruit flowers

Pollination is an important aspect of commercial kiwifruit production. Kiwifruit are dioecious; this means that the female (pistillate) and male (staminate) reproductive organs occur on separate plants. This makes pollination and the mix of male and female plants on orchard vitally important to achieving economic success.

Financial returns are dependent on the number of fruit, their size, and the percentage of dry matter in the fruit, all of which are dependent on achieving adequate pollination. Pollination is managed to a much greater extent in kiwifruit than in other crops, and the costs involved are also greater.

Achieving full pollination of kiwifruit flowers is difficult:

- Pollen must be moved large distances as male and female flowers are borne on separate vines.
- Pollination characteristics (timing, flower receptivity, bee visits required etc.) differ between the different commercial varieties, making management more complicated where more than one variety is being grown.
- Male flower pollen release and Female flower receptivity is not always synchronous. Different male cultivars flower at slightly different times from October to December. Hayward female flowers, once open, are receptive for 6-7 days with bud-burst enhancer use (10-15 days without), Gold only 2-3 days. Exact timing of flower opening depends on region, altitude, and season (average temperature).
- Female flowers need to receive thousands of pollen grains for full pollination, unlike flowers of other fruit crops that only require a few pollen grains.
- It takes many bee visits to each flower before full pollination is achieved (up to 40 bee visits for Hayward flowers, 6 for Gold).
- Fruit size (and therefore the value of the crop) is in part determined by the number of seeds the fruit contain. Export size Hayward fruit contain at least 800 seeds, Gold at least 200 seeds, and Red 250 seeds.
- Kiwifruit vines have relatively few flowers and require high levels (>80%) of fruit set (a flower becoming a fruit) compared to pip and stone fruit crops that need only a low percent fruit set.
- The flowers are not highly attractive to insect pollinators since they do not produce nectar.
- Some varieties flower late in the spring and consequently compete for insect visitors with other plants flowering at the same time.
- Kiwifruit vines were introduced into New Zealand from China, so they are without the natural insect pollinators with which they co-evolved.
- The crop needs high shelter belts to protect the vines from wind damage, which reduces pollination by wind.
- In New Zealand, vines are grown close to the ground instead of up forest trees (their natural habit), further reducing the level of wind pollination.
- Wet and/or cold weather can disrupt pollination. Flowers open and pollen release (dehiscence) is strongest in the morning, but this can be delayed in poor weather. Bees will also be less active.

	Characteristic	Hayward	Gold3	Red19
Males	Ploidy (sets of chromosomes)	Hexaploid	Tetraploid	Diploid
	Maximum effective distance to females	4-6 metres	7+ metres	6-7 metres
Female Flowers	Dehiscence	5 days	2 days	?
	Stigma Viability	8 days	2 days	4 days
Honey bee Pollination	Number of visits	40	6	?
	Min No Seeds	800	200	250
	Max number of seeds	1,200 - 1,500	600-800	600-650
	Foraging bees/1000 flowers	20	6	?

Figure 5. Comparison of pollination related characteristics between varieties. Red figures are indicative and require further research to confirm.

Kiwifruit orchards are pollinated by bees. Very few growers maintain their own beehives, most relying on the beekeeping industry to supply hives for the few weeks over flowering/pollination. The number of hives, when they are brought in, and their positioning is important. Stocking rates will vary (9-12 hives/ha); less for orchards surrounded by other orchards, more for isolated orchards. In Green orchards the bees are bought in once 20-30% of female flowers are open, earlier in Gold and Red orchards. Sunny sheltered sites help encourage bee activity.

Kiwifruit flowers do not have nectar, the usual reward for pollinators, they are only attractive because of their pollen. As a result, beekeepers supplement the bees with a sugar and water mix to reduce the chance of them foraging beyond the orchard. It is important that growers remove other flowers from the orchard and surrounding areas during pollination e.g., by mowing the sward.

Many agrichemicals are toxic to bees so crop protection sprays must be avoided or timed very carefully during flowering/pollination. Overhead cover e.g., for frost or hail protection, can also disrupt bee navigation.

Right:
Two traditional double box hives used for kiwifruit pollination

Growers supplement beehives by applying additional pollen to kiwifruit vines through other means. This activity is called supplemental or **artificial pollination.** Male only orchards are used to produce commercial supplies of pollen or growers can have some of the flowers on their own male vines picked and processed (milled) before the female flowers open. The cost of pollen varies (±$5000/kg in 2019), partly due to flower collection being extremely labour intensive, with 100kg of male buds needed to produce 1kg of pollen. The amount of pollen used will also vary with the situation, and the number of applications. Given the high cost of milled pollen, research is ongoing into bee-collected pollen. In this method, returning bees pass through a tube or screen as they enter the hive that collects the pollen they are carrying. This pollen can then be reused in one of the methods below.

Right:
Bees entering a hive through a pollen trap. Note the yellow pollen pellets that are dislodged by the tube without harming the bee

To see more about how pollen is processed go to
https://www.sciencelearn.org.nz/image_maps/10-processing-pollen

Methods of artificial pollination include:

Wet application – spraying a pollen/water mix directly on to female flowers. This is useful when bad weather reduces bee activity or there are no bees, when few male flowers are left or if there are competing flowers around the orchard. Can be labour intensive if using handheld applicators.

Dry application – blowing pollen onto the canopy which is then redistributed by bee activity. There are a variety of vehicle mounted applicators available on the market. This method may be less labour intensive but there can be considerable wastage of pollen.

READ MORE HERE:

https://www.sciencelearn.org.nz/resources/99-pollinating-kiwifruit

https://www.sciencelearn.org.nz/videos/19-artificial-pollination

3.5 THINNING

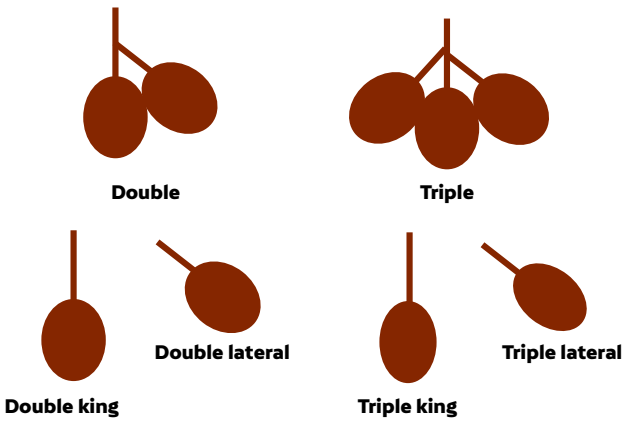
Thinning is undertaken multiple times throughout the growing season to get the optimal amount of exportable yield. Too many fruit on the vine can reduce the overall quality of the fruit by reducing average fruit size and taste. Thinning can start as soon as buds develop. Defect flower buds are removed before they develop into flowers. Lateral flower buds are removed as the fruit they produce is always substandard to that of the king flower. Removal of these buds aid pollination as bee visits are not wasted on flowers that will not become exportable fruit. It is best practice to set the desired number of buds in winter pruning, it minimises flower/fruit thinning costs and doesn't compromise fruit dry matter.

Right:
Removal of lateral flower buds is ideal before pollination.

During thinning, growers target a number of areas. They include:

- The removal of low value fruit (misshapen, damaged, undersize).
- Adjust fruit load per shoot to obtain minimum leaf: shoot ratios (2-3 leaves per fruit).
  - Spurs 1-2 fruit (approx. 5 leaves).
  - Medium terminated shoots 2-6 fruit (7-21 leaves).
  - Long terminated shoots 4-6 fruit (14-40+ leaves).
- Removal of lateral fruit as the king fruit is always larger and has higher dry matter than the lateral fruit.
- Remove more fruit from heavily shaded parts of the vine as this fruit tends to be of lower dry matter.

A final round of thinning may be completed to remove fruit with obvious defects (flats and fans, hayward mark (green), blemish that is dark coloured and larger than 1cm^2) and soft or damaged fruit before it is harvested as such fruit incurs expense when it must be removed during packing.



3.6 GIRDLING

Trunk girdling is used to increase dry matter, increase fruit weight, and increase the number of flowers the following season. Girdling refers to the removal of a thin strip of bark from around the circumference of the vine trunk or cane. This bisects the phloem so prevents the flow of carbohydrates to the roots, meaning more is allocated to the fruit in the time that the girdle is open. The plant grows a callus that heals over the girdle, reconnecting the phloem, usually within a few weeks.

Girdling is carried out at least twice in a season. A girdle applied in the spring increases fruit size. The summer girdle allows the fruit to attain a higher dry matter and can increase return bloom in some varieties. A pre-flowering trunk girdle is used by some growers to prevent or halt flower bud infection caused by bacteria, like Psa, in green cultivars.

Trunk girdles are easy to apply, with the use of a tool or a girdling chain. The tool is a double-bladed knife which cuts and removes a thin slice of bark from the circumference of a trunk. The chain is a blunt chainsaw chain with a handle at each end that is pulled back and forth to remove the bark.

Far left:
Severe girdle-cut through both the phloem and xylem. Pen shows where girdle should have finished
(*Shane Max, Zespri OPC)*

Centre left:
Correct girdle
(*Shane Max, Zespri OPC)*

Centre right:
Three healed girdles
(*Shane Max, Zespri OPC)*

Far right:
Chain used for girdling
(*Shane Max, Zespri OPC)*

Right:
Girdling knife

Technique is important. If the girdle is too shallow and has not gone through the phloem (the cambium), the root system will still be able to compete with the fruit. If the girdle is too vigorous and cuts through the xylem (the wood) it will disable the supply of water and nutrients to the canopy. The girdles will also be slower to heal, and vines will be at greater risk of disease infection. Shallow girdles are easily identified as the left-over phloem material oxidises quickly and turns brown. Using a girdling chain is generally faster but comes with increased risk of xylem damage.

Hygiene is crucial with either method: both tools and chains should be sanitised between plants, and the girdling cuts should be sprayed with a protectant solution (e.g., copper) as soon as they are completed. There is some evidence from trials in Europe that girdling may act as an elicitor and activate the plant's internal bacterial defence response, this reducing their susceptibility to Psa.

3.7 SOIL MANAGEMENT

Healthy soil is critical for success. Not only does the soil physically support plants and structures, it supplies water and nutrients to vine roots, regulates root temperature, and provides drainage from excessive rainfall. A healthy soil supports a population of microorganisms and earthworms that assist with these processes. Depending on their soil type, growers add extra organic matter in the form of compost, alongside the usual incorporation of mown grass, mulched prunings and leaves entering the soil. Ensuring drainage is sufficient is important as kiwifruit roots are very sensitive to a lack of air. If soils remain waterlogged beyond 48 hours root death can occur. Equally, the water-holding capacity of the soil in summer also impacts on soil health. Avoiding compaction of soil by heavy machinery is imperative. Wet soils are particularly at risk of compaction, so activities such as fertiliser spreading and spraying need to be carefully timed.

Soil ripping is a tool for helping to improve soil structure and drainage in heavier soils. The objective is to shatter the soil, hastening water drainage and allowing more oxygen into the soil which then encourages more root activity. Various implements are used for ripping, but timing is key. It is usually carried out in late summer when the soil conditions are drier for best effect.

Root pruning, although similar to soil ripping, serves a different function. By cutting off roots and reducing the size of the root system of the vine, the carbohydrate demands of the root system is reduced making more available for fruit growth and dry mater accumulation. The prune is completed via a large tractor-drawn pruning blade that cuts through the roots (approx. 40cm deep) on both sides of the vine. For best results root pruning is used alongside trunk girdling and is usually applied in January. Research is still ongoing, with the technique showing variable efficacy in terms of improving dry matter with soil type, root distribution, and vine age and health.

Right:
Root pruning is done with a large blade attached to the back of a tractor that drives slowly down the rows and cuts down into the soil

Far right:
Ripper attached to the back of a tractor, used to help improve soil drainage (*Shane Max, Zespri OPC)*

3.8 FERTILISER

As in any biological system where organic matter is removed (in the form of fruit), nutrients need to be returned. Nutrient management is important not only crop production but also for soil health and protection of waterways. Nitrogen (N) runoff is a key pollutant to freshwater in New Zealand, with fertilisers and drainage (from rainfall or irrigation) potential sources of N leaching that need to be managed on orchards.

Smart fertiliser use considers the "4Rs":

1. At the **right rate**
2. Of the **right type**
3. Delivered to the **right place**
4. At the **right time**

A soil test is usually taken after harvest (early winter) when the soil is cooler and the vines are dormant. Soil testing determines the levels of the key nutrients present in the soil - phosphorus (P), potassium (K), Calcium (Ca), Magnesium (Mg) and nitrogen (N). Testing also indicates how readily soils can absorb nutrients and make them available to plants (based on pH and Cation Exchange Capacity results). This information, along with the previous season's yield and growth response can form the basis for a fertiliser recommendation (**right rate**).

Fertilisers come in different forms and methods of application (**right type**)

- Ground applied solid fertilisers - Calcium Ammonium Nitrate (CAN) is the most common form of Nitrogen based fertiliser used, along with Sulphur of Potash (SOP), the most common form of potassium fertiliser. Orchardists usually attempt to time fertiliser spreading before a light rain event to help integrate it into the soil (but not heavy rain events that would cause run-off). Little and often is most effective for fertiliser application.
- Foliar fertilisers – soluble fertilisers spayed on to foliage, most commonly Urea. Applied preharvest, foliars support early season growth, support the vines through periods of stress (e.g. cold snaps), can correct nutrient deficiencies, and improve fruit quality, and/or to increase fruit size. Foliars may also be applied postharvest to accelerate leaf drop or to build plant reserves for the following spring. They are used in addition to solid fertilisers.
- Fertigation – soluble fertiliser applied to vines via an irrigation system. This provides greater ability to apply smaller amounts of nutrients often, targeted at the root zone (**right place**) resulting in improved nutrient use efficiency and reduced nutrient losses. Fertigation is a relatively new method of fertilisation and research is still ongoing. It is promising for light soils with low nutrient holding capacity and organic matter, and for heavy soils where root growth is constrained near the surface. The biggest constrain for growers is access to water.

Spring is the best time for plants to take up nutrients (**right time**). For best uptake and to limit leaching, fertiliser application should be avoided ahead of or during heavy rain, or when soils are clogged, overly wet or waterlogged.

Read more about sustainable nutrient management in Ch 4.4.3.

Right:
Fertiliser spreading

3.9 CROP PROTECTION

The Zespri Crop Protection Standard advises growers which agrichemical compounds may be applied to fruit that will be marketed by Zespri. There are different standards for conventional and organic production systems. These standards ensure fruit meets the legal requirements in each country where Zespri fruit is sold and that customers and consumers requirements for safe fruit, produced in an environmentally responsible manner, are also met.

Integrated Pest Management

Kiwifruit are susceptible to a range of pests and diseases which can affect vine health, fruit quality, or restrict access to important export markets. The best method for crop protection is an integrated pest management approach that includes:

- Monitoring for pests and diseases.
- Applying appropriate agrichemicals at the right time and at the correct concentration.
- Using cultural controls to further minimise pests and diseases.
- Implementing orchard hygiene measures to prevent the spread of pest and diseases.

Agrichemical Controls

Pest and disease control using agrichemicals is an essential part of modern orchard management. Pests such as scale and leafroller, and diseases such as Psa and Sclerotinia, often require agrichemicals to control their numbers. Agrichemicals should only be applied if they are required, therefore monitoring for pests is essential for growers to determine what agrichemicals they should be using.

Agrichemicals for pest and disease control can be grouped into three categories: systemic, contact and preventative. Systemic agrichemicals travel through the plant after they enter through healthy leaves, where they can poison or disrupt the lifecycle of pests and diseases. Contact agrichemicals rely on excellent spray coverage, as they depend on touching the pest or disease that they target. Preventative agrichemicals tend to make the plant unappealing to a particular pest or disease, by methods such as altering the taste of the plant or changing the pH of the leaf surface.

Right:
Sprayer applying an agrichemical to dormant vines in winter

Cultural Controls

Cultural controls are often simple non-chemical methods which result in more effective control of pests and diseases. Examples include:

- Ensuring plant species used for shelter are not those favoured by pests e.g., poplar and willow can be hosts for scale insects.
- Removal of host plants from the orchard surrounds e.g., Passionvine hopper (PVH) readily lay eggs on blackberry, bracken, and mahoe.
- removing overly large crowns from vines during winter pruning to reduce the number of crevices where scale insects can hide.
- mulching the grass sward under the vines immediately prior to flowering to reduce the ability of Sclerotinia spores to drift from the ground up to the canopy.

Orchard Hygiene

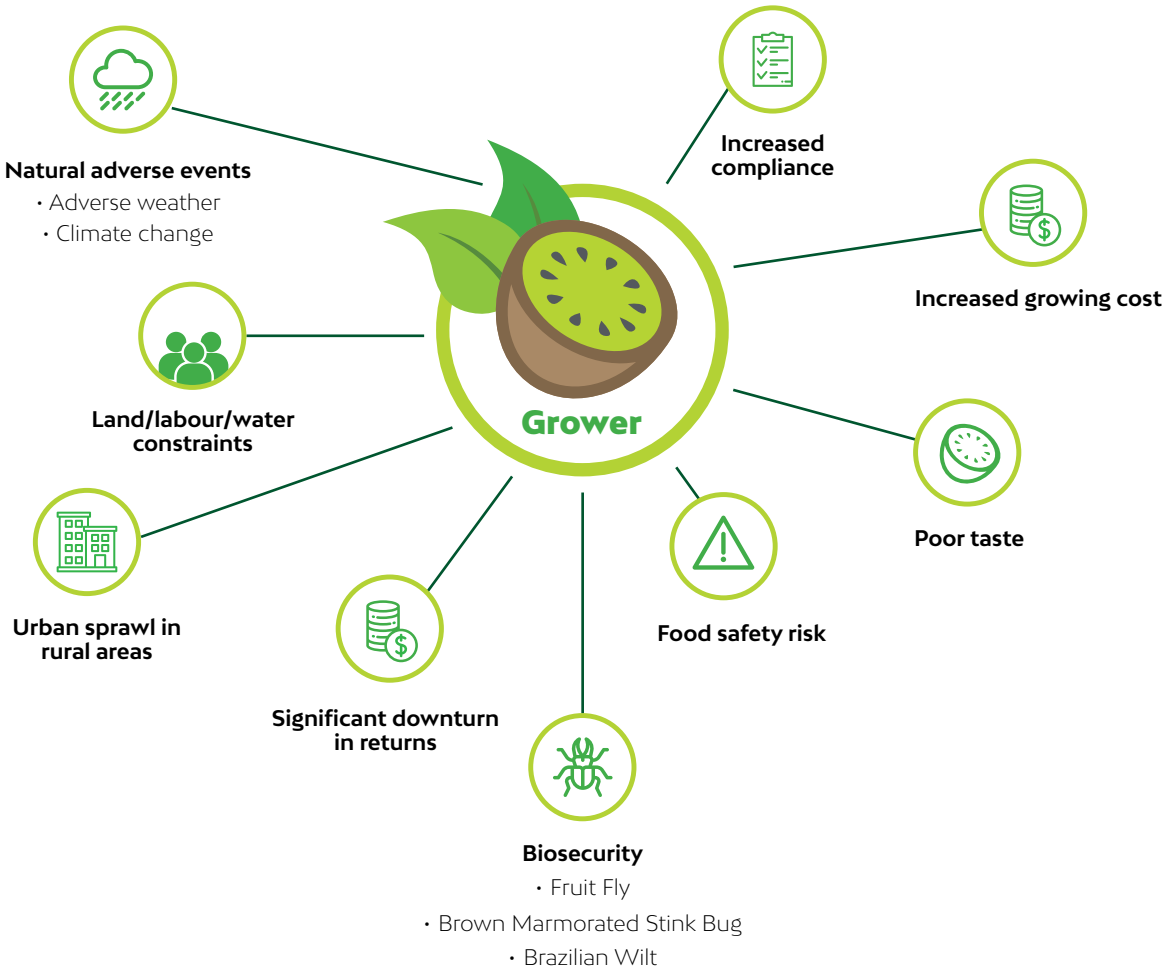
Keeping tools and equipment clean and sanitised is a key strategy for minimising the spread of pests and diseases. Virulent diseases such as Psa can spread from vine to vine on pruning tools and can move between regions through new plants or budwood; soil-borne diseases can be transported onto an orchard in mud on boots or tractor tyres; and pests can be transported in machinery imported from other countries.

Sterilising pruning and girdling tools between every vine, using foot baths when entering an orchard, and thoroughly cleaning machinery can all help to prevent or slow down the spread of pests and diseases.

3.10 ORCHARD RISK MANAGEMENT

It is important the growers plan risk into their business model to ensure sustainable profitability. The following diagram illustrates some of the immediate risks growers should take into consideration. Please note that there are wider risks which also impact upon grower profitability such as market access or geopolitical changes. Below is a diagram outlining the various risks that growers could encounter throughout their orchardist careers.

Immediate risks to growers



CHAPTER FOUR

SCIENCE AND SUSTAINABILITY

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER FOUR
SCIENCE AND SUSTAINABILITY

Over the past few years, the kiwifruit industry has vastly increased its focus on sustainability. Consumers are expecting more from businesses in terms of sustainability – they care about what their food is wrapped in and want to know more about where it comes from and that it has been grown in a way that enhances the environment and support livelihoods. As well as investigating some of the drivers of sustainability, this chapter focuses on some of the science topics that support this.

THE SECTION IS DIVIDED AS FOLLOWS

4.1 THE DRIVERS FOR SUSTAINABILITY

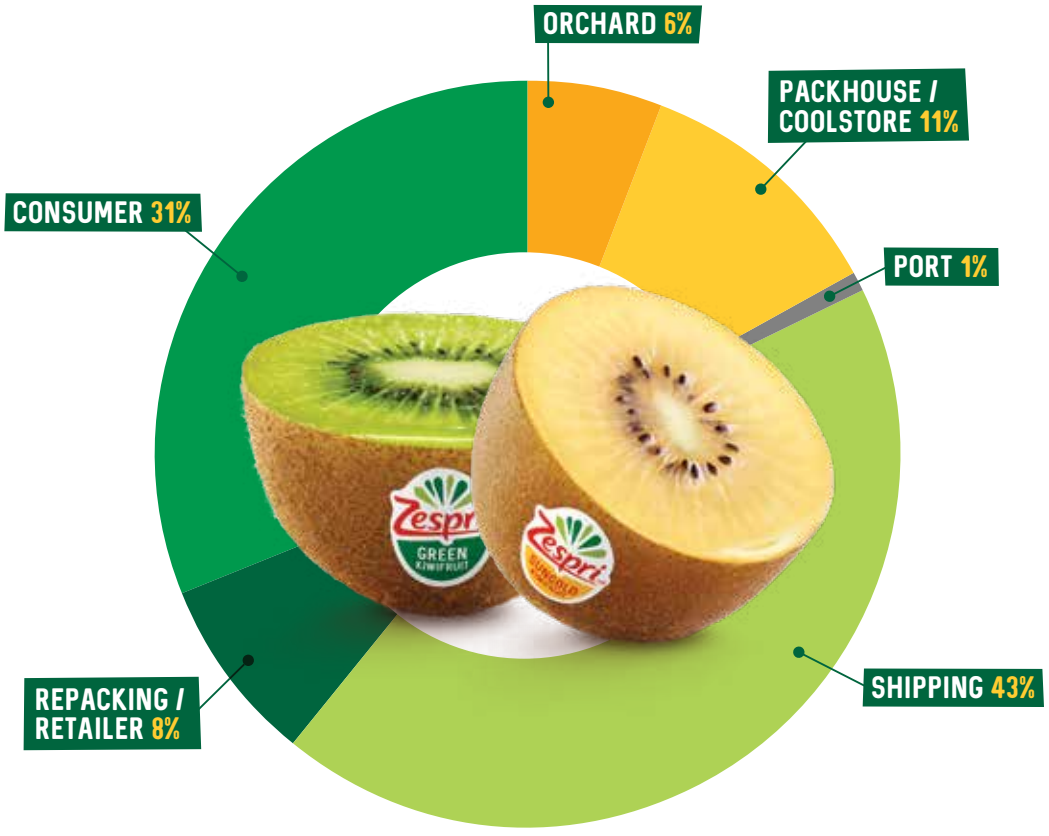
In the mid-2000s, global retailers were challenged by non-government organisations to reveal the environmental cost of sourcing products. At that time, kiwifruit was cited as an example of a product that was grown, stored and shipped long distances to be sold in Europe. By partnering with government, including the Ministry of Foreign Affairs and Trade and the Ministry for Primary Industries, Zespri co-funded research on determining the carbon and water footprints for kiwifruit grown in New Zealand and consumed in Europe.

Carbon footprint represents the amount of greenhouse gas emissions associated with an organisation, event or production. An increase in greenhouse gas emissions is the primary driver of global warming and climate change. In NZ, the main greenhouse gas is methane from agriculture. For horticulture, including kiwifruit production and distribution, the main greenhouse gas is carbon dioxide.

Essentially, the findings highlighted that the environmental impacts of New Zealand kiwifruit were comparable to those of competitors, including kiwifruit grown within Europe. This information was then communicated to Zespri's retail customers, where it helped alleviate major concerns about New Zealand's Kiwifruit. This example highlighted to the kiwifruit industry that there was a need to better understand the environmental impacts of kiwifruit so that Zespri could respond more quickly to any questions related to this topic from the markets or local communities.

CONTRIBUTION OF EACH STAGE

In the supply chain to the carbon footprint of Zespri Kiwifruit produced in New Zealand and consumed globally (2017 crop).



4.2 ZESPRI'S SUSTAINABILITY PRIORITIES

In 2010, Zespri developed a strategy to manage the environmental risks associated with fresh kiwifruit production and consumption. At that time, the top five globally important environmental impact areas were identified. These areas were greenhouse gas emissions (carbon footprint), water, waste, non-renewable resources and biodiversity. The state of these across the New Zealand kiwifruit sector were then assessed over the ensuing years to manage the associated risks and opportunities.

More recently, the kiwifruit industry has increased its focus on sustainability. Retailers require increasing transparency of the growing systems, inputs, environmental measures, and labour practices that sit behind the product on their shelves – both to protect their own reputations and to position themselves against competitors. As the industry adopts sustainable business practices that earn the trust of consumers and communities, the value of the Zespri brand will strengthen as well as enable the continued growth of our industry.

Zespri has developed a framework for sustainability, setting out their priorities under the three pillars of:

Our Kiwifruit - promote healthy eating and lifestyles, actively encouraging people to eat better and live healthier.

Our Environment - striving to address how production, supply and sales impact on and enhance the environment with a focus on packaging, water quality and climate change.

Our Communities - making a positive contribution to peoples' livelihoods and wellbeing, through the returns provided to growers, the working conditions provided for our people, and the contributions we make in our markets.

4.3 OUR KIWIFRUIT

Health and Wellbeing Benefits of Kiwifruit

Nutrient Density

Right:
Comparison of the nutrient adequacy and nutrient density properties of Zespri kiwifruit and other commonly eaten fruit

	NUTRIENT ADEQUACY
KIWIFRUIT, ZESPRI SunGold	14.2
LONGAN	12.8
AVOCADO	10.8
KIWIFRUIT, ZESPRI GREEN	8.7
DURIAN	8.5
MELON (CANTALOUPE)	7.0
ORANGE	6.8
MANDARINS	6.7
POMEGRANATES	6.2
PEARS	4.1
MANGO	4.0
BANANAS	3.7
PINEAPPLE	3.7
CHERRIES	3.4
CRANBERRIES	3.1
STRAWBERRIES	3.1
TOMATO	2.7
WATERMELON	2.7
BLUEBERRIES	2.6
GRAPES	2.5
APPLES	1.9
PAPAYA	1.9

	NUTRIENT DENSITY
KIWIFRUIT, ZESPRI SunGold	22.5
LONGAN	21.3
MELON (CANTALOUPE)	20.6
TOMATO	14.9
ORANGES	14.4
KIWIFRUIT, ZESPRI GREEN	14.3
MANDARINS	12.7
STRAWBERRIES	9.7
WATERMELON	8.9
POMEGRANATES	7.4
PINEAPPLE	7.3
PEARS	7.2
CRANBERRIES	6.8
MANGO	6.7
DURIAN	5.8
AVOCADO	5.4
CHERRIES	5.4
BLUEBERRIES	4.5
PAPAYA	4.4
BANANAS	4.2
APPLES	3.6
GRAPES	3.6

Nutrient adequacy is a measure of how many nutrients the fruit provides relative to its weight. The calculation factors the nutrient composition of each fruit as a percentage of the of the Recommended Daily Allowance (RDA) for 16 specific vitamins and minerals, including protein, fibre, calcium, iron, vitamin A, thiamin B1, riboflavin B2, niacin B3, vitamin B6, vitamin B12, folate, vitamin C, vitamin D, vitamin E, pantothenic acid B5, and magnesium.

Nutrient density measures how many nutrients the fruit provides relative to the number of calories it contains i.e., the nutrient adequacy score is divided by the number of calories the fruit has. The high amount of vitamin C in kiwifruit is the primary driver of its high nutrient adequacy score. Other nutrients boosting this score include fibre, folate, and vitamin E. Kiwifruit's high nutrient density is one of the key advantages it has over other commonly eaten fruit.

Vitamin C

Vitamin C plays a significant role in maintaining good health by influencing various components of the immune system and promoting a general feeling of vitality. Vitamin C helps to activate a number of enzymes in your body that improve metabolic energy levels and different neurochemicals in the brain.

Humans can only obtain vitamin C through their diet, and because the body can only store a limited amount vitamin C needs to be ingested daily. Various fruits and vegetables are rich in vitamin C, and kiwifruit is one of the best sources of vitamin C among fruit and vegetables.

Kiwifruit is high in vitamin C which helps strengthen the body's natural defenses

Right:
Vitamin C content comparison graph

Dietary Fibre

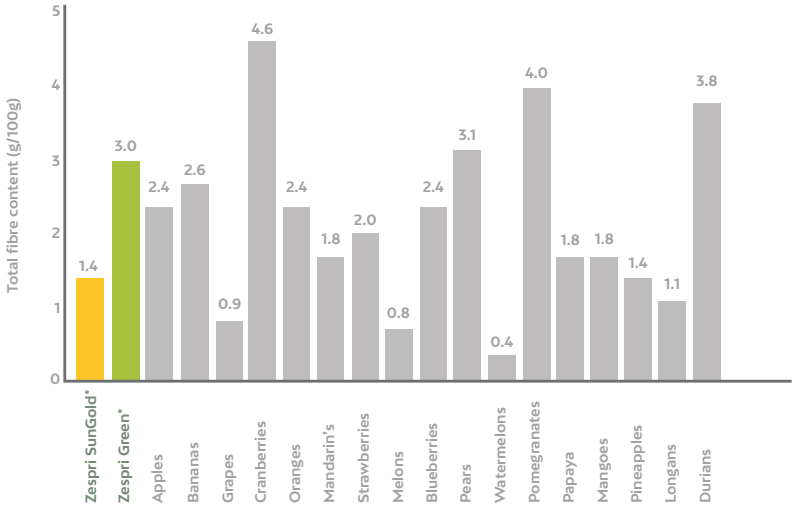
Dietary fibre is made up of plant components that reach the intestine without being digested and undergo total or partial fermentation in the large bowel by gut bacteria. Dietary fibre has been linked with a multitude of health benefits including digestive health, the regulation of glucose in the blood, blood cholesterol levels and weight management.

There are two types of fibre, both necessary for good health:

- **Soluble fibre** (pectin, gums and mucilage) found mainly in plant cells: Helps to lower blood cholesterol levels and can help to reduce constipation. Found in fruits, vegetables, oat bran, barley, flaxseeds, dried beans, lentils, peas and soy products.
- **Insoluble fibre** (cellulose, hemicellulose and lignin) from the structural part of plant cells: The main effect of insoluble fibre is to add bulk of faeces, and to alleviate constipation and associated problems such as haemorrhoids. It is also linked to reduced cardio-vascular risk. Found in wheat bran, corn bran and rice bran, the skins of fruits and vegetables, nuts, seeds, legumes and wholegrain cereals.

Kiwifruit contains both soluble and insoluble fibre at a ratio of approximately 1:4 in Green Kiwifruit and 1:3 in SunGold. Pectic polysaccharides (the soluble fibre in kiwifruit) have the ability to retain water and form gels, which supports digestive comfort.

Right:
Fibre content comparison graph



* USDA Nutrient Database 2012 (Release 28) ** New Zealand FOODfiles 2014 Version 01

Folate

Folate (vitamin B9) is an essential nutrient for cell growth and development and is important in the formation of the red blood cells which transport oxygen, iron and other minerals. Women need significantly higher levels of folate before and during pregnancy. It is vital for normal fetal development e.g., for reducing the incidence of neural tube defects. Folate is so important for healthy body functioning that many countries fortify bread and flour with folic acid (synthetic form) to ensure more of their population, particularly women, have an adequate dietary intake. However, between 50 to 80% of folate is destroyed if cooked, so kiwifruit that are generally eaten raw are an excellent source.

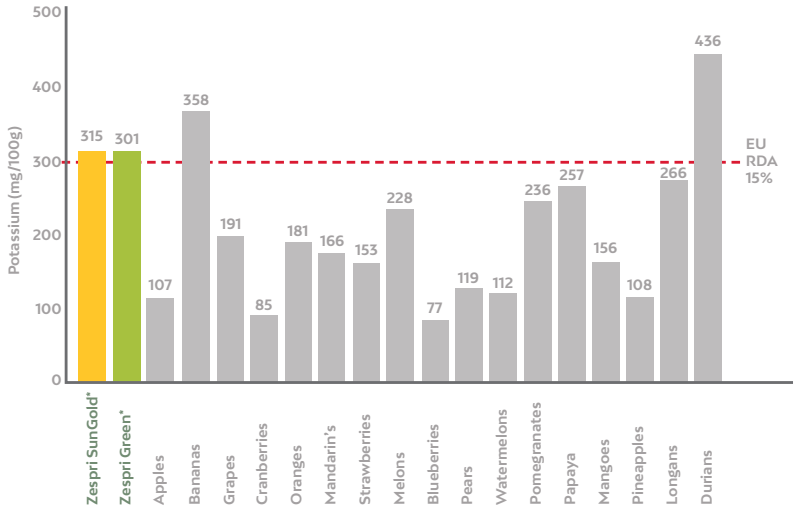
Below:
Folate content comparison table

	MEASURE	DIETARY FOLATE	US RDA*	US RDA	EU PRI*	EU RDA	NZ RDI*	NZ RDI
	g	µg	µg	%	µg	%	µg	%
AVOCADO	100	110.0	400	27.50	330	33.33	400	27.50
MANGO	100	43.0	400	10.75	330	13.03	400	10.75
KIWIFRUIT, ZESPRI GREEN	100	38.0	400	9.50	330	11.52	400	9.50
POMEGRANATES	100	38.0	400	9.50	330	11.52	400	9.50
PAPAYA	100	37.0	400	9.25	330	11.21	400	9.25
DURIAN	100	36.0	400	9.00	330	10.91	400	9.00
MANDARINS	100	34.0	400	8.50	330	10.30	400	8.50
KIWIFRUIT, ZESPRI GOLD	100	31.0	400	7.75	330	9.39	400	7.75
ORANGES	100	27.0	400	6.75	330	8.18	400	6.75
STRAWBERRIES	100	20.0	400	5.00	330	6.06	400	5.00
MELON (CANTALOUPE)	100	19.0	400	4.75	330	5.76	400	4.75
BLUEBERRIES	100	12.0	400	3.00	330	3.64	400	3.00
PEARS	100	7.0	400	1.75	330	2.12	400	1.75
CHERRIES	100	6.0	400	1.50	330	1.82	400	1.50
PINEAPPLES	100	5.0	400	1.25	330	1.52	400	1.25
TOMATO	100	2.6	400	0.65	330	0.79	400	0.65
GRAPES	100	2.0	400	0.50	330	0.61	400	0.50
CRANBERRIES	100	1.0	400	0.25	330	0.30	400	0.25
APPLES	100	0.0	400	0.00	330	0.00	400	0.00
BANANAS	100	0.0	400	0.00	330	0.00	400	0.00
WATERMELON	100	0.0	400	0.00	330	0.00	400	0.00
LONGAN	100	N/A	400	N/A	330	N/A	400	N/A

Potassium

Potassium is an important mineral for the normal function of the nervous system and muscular contraction. It is also beneficial in maintaining normal blood pressure and heart health. Potassium maintains fluid and electrolyte balance. Food processing tends to lower potassium levels and increase sodium levels (with associated negative impacts on health). Whole, fresh foods such as fruits, green vegetables and cereals or wholemeal bread are generally higher in potassium and lower in sodium. Kiwifruit is a great natural source of potassium, almost comparable to bananas – the fruit traditionally linked with potassium.

Right:
Potassium content comparison graph



* USDA Nutrient Database 2012 (Release 28) ** New Zealand FOODfiles 2014 Version 01

Actinidin

Uniquely, Kiwifruit contains actinidin, a highly active cysteine protease enzyme. This enzyme can break down a wide range of food proteins more completely and faster than the body's digestive enzymes can do on their own. Actinidin may also play a role in maintaining muscle health as enhanced food protein digestion in the small intestine improves protein absorption, which is linked to muscle repair. It has been observed that the presence of actinidin causes a more rapid emptying of the stomach when digesting beef. This means that eating kiwifruit with a protein-rich meal can offer benefits for people with a compromised digestive system and help reduce the sensation of heaviness and the gastric disturbances typical of protein-rich diets.

Levels of actinidin in kiwifruit differ between varieties although the methods of testing and reporting differ so comparison is difficult. Generally, Green kiwifruit contain the highest amounts of actinidin, with lesser amount in Gold varieties and virtually none in Red. Actinidin levels may also be a function of maturity of the fruit.

Kiwifruit, Actinidin and food allergies

Actinidin may be responsible for a small number of people who report allergic reactions to kiwifruit. Those that have mild allergies to Green Kiwifruit do not typically have the same reaction to SunGold but should consult a healthcare professional before trialling it.

Antioxidants

Antioxidants, found in certain foods, scavenge and neutralise free radicals from the body's cells and prevent or reduce the cell damage caused by oxidation. These include the nutrient antioxidants vitamins A, C and E and a range of biologically active phytochemicals. Vitamin E and the polyphenols and flavonoids found in both Green and SunGold are the major contributors to the antioxidant capacity of kiwifruit. Quercetin, a flavonoid in kiwifruit, has both antioxidant and anti-inflammatory properties. Carotenoids lutein and zeaxanthin also support antioxidant function in the body, particularly in eye health. Gold kiwifruit is particularly high in the polyphenol epicatechin, and Green kiwifruit has a range including epicatechin, lutein and kaempferol. While it is not possible to link the polyphenolic compounds in kiwifruit to any specific health benefit, strong evidence exists demonstrating that eating foods with polyphenolic compounds contributes to good overall health. 30% of the total polyphenols in SunGold are found in the skin, so plan to eat them with the skin on.

Glycaemic Index

The Glycaemic Index (GI) is a relative ranking of carbohydrates in foods according to how they affect blood glucose levels. Different foods are classified as High, Medium or Low on the Glycaemic Index.

- High GI **>70**
- Medium GI **55-70**
- Low GI **<55**

High GI foods are rapidly digested and absorbed, and result in a rapid, marked rise in plasma glucose levels, whereas the same amount of carbohydrate in low GI foods are more slowly digested and absorbed, resulting in a gradual rise in plasma glucose response and insulin levels. Management of blood sugar levels is particularly important for people with Pre-diabetes and Diabetes, a growing portion of the population.

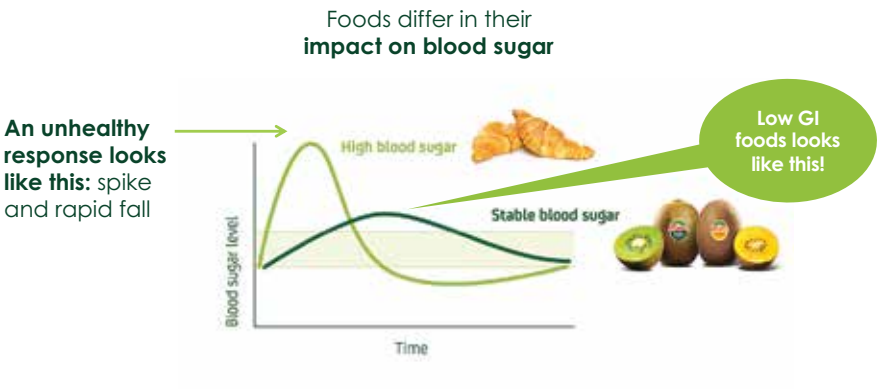
Right:
Glycaemic Index table

	Serving Size	Glycaemic Index	Glycaemic Index Rank
	9	Glucose comparison - 10g CHO	L.M.H
Avocado	100	15	L
Tomato	100	15	L
Kiwifruit, Zespri SunGold	100	38	L
Apples	120	39	L
Kiwifruit, Zespri Green	120	39	L
Strawberries	120	40	L
Oranges	120	43	L
Bananas	120	47	L
Mandarins	120	47	L
Durian	100	49	L
Mango	120	51	L
Blueberries	100	53	L
Papaya	120	56	M
Grapes	120	59	M
Pineapple	120	59	M
Cherries	120	63	M
Melon (Cantaloupe)	120	70	H
Watermelon	120	76	H
Cranberries	100	n/a	n/a
Longan	100	n/a	n/a
Pears	100	n/a	n/a
Pomegranates	100	n/a	n/a

> “There is growing evidence highlighting that consuming of kiwifruit has a positive impact on the microbiota in the colon which have also recently been identified as a new potential factor in obesity-related disorders.”

Approximately 80% of the dry weight of ripe kiwifruit consists of available carbohydrates, including glucose, fructose and sucrose at a ratio of about 2:2:1. The remaining 20% of the dry weight of kiwifruit consists of protein (10%) and fibre (10%).

Right:
How foods affect your blood sugar



Of these sugars, glucose has a GI of 100% (the benchmark), fructose 19% and sucrose 68%. With a low GI of 38-39, combined with a modest content of carbohydrate, and a fibre component that slows the rate of absorption, kiwifruit is an excellent fruit choice for people with diabetes trying to manage their blood sugar levels.

There is growing evidence highlighting that consuming of kiwifruit has a positive impact on the microbiota in the colon which have also recently been identified as a new potential factor in obesity-related disorders. Growing evidence in clinical studies suggests that alterations in the colonic microbiota of people with obesity may lead to chronic low-level inflammation, insulin resistance and onset of Type 2 diabetes.

4.4 OUR ENVIRONMENT

Organic Production

Consumers are becoming increasingly concerned about how their food is produced and the associated impacts of getting fruit to market. Some consumers look for options that are more environmentally friendly, in particular organics, and this is driving significant growth - "The organic market is the fastest expanding, multi-food category globally, pushing double digit global growth over the last decade and is now mainstream. The world wants safe, clean, honest food." (2018 OANZ Report).

In 2021, there are 439 hectares of organic green kiwifruit and 142 hectares of organic gold kiwifruit in production. Organically grown kiwifruit generally has lower average yields than conventionally grown kiwifruit, however this is offset by a premium over conventional fruit. It is therefore possible for the returns of organic growers to be as good if not better than conventional growers. The core markets for Zespri Organic are North America, Europe and Japan which account for over 80% of global sales by volume (2018 OANZ Report).

Zespri Organic Kiwifruit is grown to the strictest organic standards and is certified by Bio-Gro, New Zealand's organic protocol organisation. Key input differences are that fewer agrichemicals can be used on organic orchards and synthetic nitrogen (e.g., CAN, urea) is not permitted.

A study undertaken by The Agriculture Research Group on Sustainability (ARGOS) found that the environment of kiwifruit orchards is good regardless of whether they are organic or conventional, but that there are some differences between organic and conventional systems. For more information visit: www.argos.org.nz.

4.4.1 Packaging

Like many other products, kiwifruit is exported around the world in packaging designed to protect it and ensure the best quality fruit is delivered to consumers. In recent years, images of damage to wildlife caused by plastic have put a spotlight firmly on plastics in supply chains. In recognition of this concern and to meet increasing customer requirements for less plastic, in 2019, Zespri signed up to a New Plastics Economy Global Commitment to have packaging that is 100% reusable, recyclable, or compostable by 2025.

See: https://ellenmacarthurfoundation.org/topics/plastics/overview

Further, Zespri is striving to ensure that any plastic packaging used will be made from at least 30% recyclable plastic by 2025, and that they will reduce the packaging footprint, per kg of fruit, by 25% by 2030. Significant pieces of research are underway to achieve these goals related to better understanding the current packaging used and it's impacts, and to find alternative materials or solutions that will allow the continued deliver of high-quality fruit to consumers. This work also includes finding more sustainable alternatives for fruit labels.

4.4.2 Water

Declining freshwater quality and availability has become a global concern. Although by world standards, New Zealand has clean and abundant freshwater, the quality in some of New Zealand's rural and urban areas has been come under increased pressure due to land use intensification and the loss of nutrients (e.g., urine and fertilisers) from farms into waterways.

Water Strategy

Sustainability is a key driver in the NZ kiwifruit industry – both in terms of our returns and our impact on communities and the environment. The industry has developed a water strategy to protect and enhance water resources for our people, our environment and our communities while enabling the industry to grow. The Water Strategy includes looking at how we use water, how we can do so in the most sustainable way and how we can gather data to measure our progress and improve. The strategy was created in 2019 by NZKGI, Zespri, Māori Kiwifruit Growers, Horticulture NZ and growers. It is supported by four working groups who are working towards a range of objectives that will improve water quality and use on orchards.

The strategy can be found on NZKGI website: https://www.nzkgi.org.nz/wp-content/uploads/2020/09/J002013_Water_Strategy_Document_Update_R2_Final_WEB_Small.pdf

National Water Policy

The government is focused on improving water quality around New Zealand and making sure that people only use what they need. To ensure that this happens, the government has developed Essential Freshwater Policy which has a number of regulatory measures, which include:

1. **National Policy Statement for Freshwater Management**
   The clearing of native vegetation, New Zealand's growing population, urbanisation, farming/forestry, the drainage of wetlands and the damming and modification of rivers and streams have all had significant effects on our land and placed increasing pressure on our water bodies and ecosystems. In response to this, and to protect freshwater quality, the New Zealand Government established a National Policy Statement for Freshwater Management (NPSFM) in 2014 which was amended in 2017 and in 2020. The NPSFM directs regional councils, in consultation with their communities, to set objectives for the state of freshwater bodies in their regions and to set limits on resource use to meet these objectives.

   Regional Councils are currently implementing the NPSFM via regional plans and are required to notify plans no later than 31 December 2024. The NPSFM can be found on the Ministry for the Environment website: https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/national-policy-statement-for-freshwater-management-2020.pdf

2. **National Environmental Standard Freshwater**
   A new national standard was released in 2020 and provides specific direction on water use, in particular where rapid action is required, for example, in at-risk catchments.

   The new rules can be found on the Ministry for the Environment website: https://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/action-for-healthy-waterways-information-for-horticultural-growers-updated.pdf

3. **Review of the Resource Management Act (RMA)**
   A review of the RMA was completed in 2020 and was undertaken in recognition that the current is no longer considered fit for purpose. The specific aim of the review was to improve environmental outcomes and better enable urban and other development within environmental limits.

   The review provided a summary of key recommendations which can be found on the Ministry for the Environment website: https://www.mfe.govt.nz/rmreview The next step in the reform process will be consultation to develop government policy and the form of future legislation.

4.4.3 Sustainable Nutrient Management

When the term 'sustainable nutrient management' is used, it is often in relation to maintaining or improving freshwater quality. The most prevalent problem is eutrophication which is the nutrient enrichment of freshwater bodies leading to the growth of unwanted aquatic plants like algae and rooted plants. Excessive levels of nutrients in water can also be harmful to animals and humans, particularly infants.

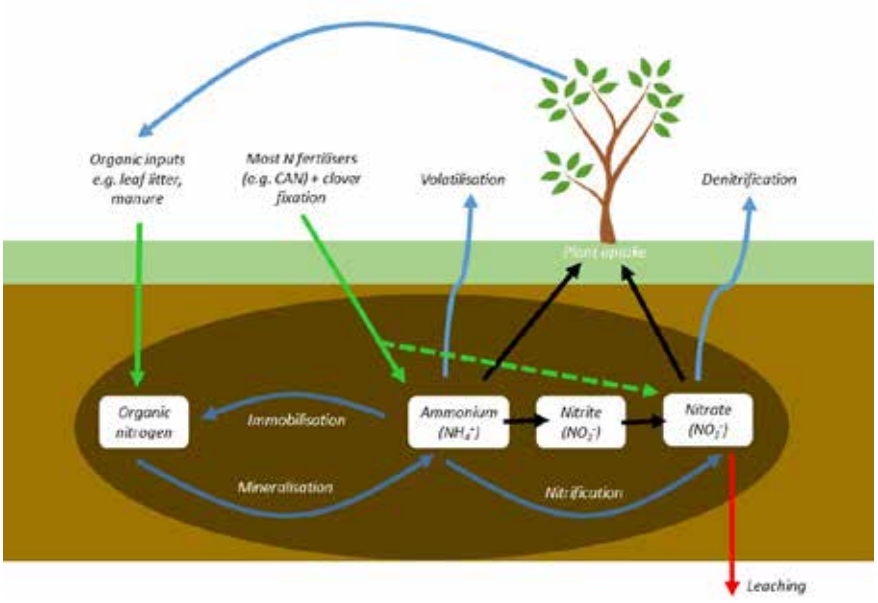
Nitrogen (N) and Phosphorus (P) are presently the main nutrients of concern and must be carefully managed as the input of these into a water body can significantly affect its quality. Consequently, there is growing social and regulatory pressure to mitigate the impacts of these. Understanding the N and P cycles, and how these can move from land and into water bodies is key to managing these nutrients effectively. Losses of sediment and E. coli to freshwater are also a concern in some places.

Leaching

Leaching refers to the loss of nutrients and other chemicals through the soil with water as it drains through. Weather (particularly rainfall), soil characteristics, irrigation, fertiliser practices and plant uptake are the main factors that contribute to leaching from kiwifruit orchards. An orchard with a free draining soil that is saturated, where soluble fertiliser is applied prior to a major drainage event (e.g., heavy downpour) may lose a significant amount of nutrients.

Nitrogen (N) is the main leaching risk for freshwater quality. This is because nitrogen applied to or already present in the soil is converted to nitrates (NO3-), which are not strongly held by the soil and are therefore are readily leached with water as it drains down through the soil profile. Although N is usually available in the soil for plant uptake initially in the form of ammonium, which leaches much less, this is converted to nitrate through the microbial process of nitrification (see figure below).

Right:
Soil nitrogen cycle for a plant-based system



How Much N is applied to Kiwifruit Orchards and How Much is Leached?

Generally, mature kiwifruit orchards generally receive around 100 kg N/ha/yr (Nitrogen/per hectare/per year), give or take about 20%. Developing orchards may receive more to develop canopy quickly. On conventional orchards, more soluble fertilisers like calcium ammonium nitrate (CAN; 27% N) are commonly applied while on organic orchards, relatively insoluble inputs like composts are often used, at 5-10 tonnes/ha; developing orchards and orchards where soil organic matter is low may receive considerably more compost than this.

The associated N losses to water from kiwifruit orchards has previously been modelled to be typically less than 20kg NO_3-N/ha/yr on average (for orchards in the Bay of Plenty where most orchards are located) . However, the model (OVERSEER™) used for this has not been well calibrated for kiwifruit so there is some uncertainty around the accuracy of these values. Research is therefore underway to better understand losses from orchards. In this, nitrogen losses are being directly measured using drainage fluxmeters.

As far as ecological and human health concerns are framed, it's the concentration of nitrate-nitrogen (mg N/L, or parts per million) in water that is important, not the loading (kg N/ha/yr). High concentrations of nitrate in drinking water can pose a health risk for certain people, particularly bottle-fed babies who drink formula made with the water. For this reason, the Ministry of Health has a Maximum Acceptable Level (MAV) of 11.3 mg/L (or parts per million) for nitrate-nitrogen. Measured and modelled values for kiwifruit on average have been found to be below this.

How are Nutrient Losses Determined?

Directly measuring nutrient losses from farms is not practical and is expensive. Therefore, models are often used to estimate losses. In kiwifruit, two models called OVERSEER™ and SPASMO have been used previously as these have dedicated kiwifruit components. OVERSEER™ is the most widely used model in New Zealand agriculture and is being used to develop nutrient budgets i.e., reports showing the amounts of nutrients added and lost from farms. In some places it is mandatory for OVERSEER™ to be used in order to obtain consent to farm. Overseer is not used much in the kiwifruit industry, one of the reasons being that it has not yet been well calibrated for kiwifruit and should therefore be used with caution.

For more information, visit http://overseer.org.nz.

Phosphorus

Phosphorus is the other main nutrient of concern for freshwater quality. Like N, too much P in aquatic environments can lead to excessive plant growth, algal blooms and the depletion of oxygen dissolved in the water. But unlike N, the main pathway for P entering our waterways is via run-off, unless the soils are coarse pumice or sandy in which case leaching could occur. Generally, P losses from kiwifruit orchards are thought to be low because orchards are relatively flat and so surface run-off of water is lower. Also, features like grass swards and shelterbelts impede run off. Research is underway to measure P run-off from kiwifruit orchards.

Recommended Practices for Sustainable Nutrient Management in Kiwifruit

The 4Rs of Nutrient Stewardship

This is the concept of applying the right fertiliser source at the right rate at the right times in the right place. More specifically:

- Fertiliser inputs should match what the plant requires taking into account production goals as well as the availability of nutrients in the soil. The process of mineralisation (i.e., release of N from organic matter) should be considered as this can supply nitrogen for plants. Applying higher amounts of N may not necessarily increase production but result in unwanted vigour.
- Don't apply N when the drainage risk is high, for example in the wetter winter months and when the soil is waterlogged.
- If N is applied in one application, then some of that will not be taken up by the plant and be available in the soil to be leached. First application of the season should be as close to bud break as practical. Applying well before in wetter months does not advantage N uptake but increases the risk of leaching. Generally, for kiwifruit it is recommended to split applications i.e., apply around two thirds prior to budbreak and the rest in late spring/ early summer, prior to fruitset.

Other options for minimising nutrient losses in a kiwifruit orchard are presented below. Growers should consider how these might affect their economic and production objectives.

Plant Vegetation Around Waterways

Buffer zones of vegetation adjacent to waterways act as a last line of defence and will filter nutrients as well as reduce erosion and enhance biodiversity. These zones are commonly referred to as riparian zones.

Minimise Bare Ground

Plants present in orchards will take up nutrients that would otherwise be lost. Ground cover also protects the soil which is beneficial. Research is proposed to better understand the benefits of ground covers in kiwifruit orchards where low light conditions are a challenge to establishment, as are other practices such as agrichemical use. Having a sward with clover present instead of bare ground is beneficial as it will add N to the orchard system because the clover assimilates N from the atmosphere (through the process of nitrogen fixation).

Sustainable Management Practices: How does your region measure up?

For the regions where kiwifruit is mostly grown, freshwater quality is generally stable or improving although some individual measures in some regions have been deteriorating. To view freshwater quality trends for a specific region or catchment, visit the Land Air Water Aotearoa (LAWA) website http://www.lawa.org.nz.

Maintain Plant Health

Ensuring good plant health and healthy root systems will help to prevent leaching by ensuring the plants are functioning optimally to take up nitrogen.

Consider Less Soluble Forms of N

Organic fertilisers for example are thought to be inherently less soluble and N leaching risk is less. However, they may not deliver sufficient available nutrients to meet fruit production goals. Less soluble forms of synthetic fertiliser (e.g., slow or controlled release) are also available, however like organic forms they may not supply sufficient nutrient when required and are usually more expensive.

4.4.4 Climate Change

The Earth's climate is warming, which will lead to more weather variability and extremes as the average temperatures rise. Zespri has reported on the climate-related risks to the kiwifruit industry.

They used a scenario-based approach as is recommended by the Task Force on Climate related Financial Disclosure (TCFD), Intergovernmental Panel on Climate Change (IPCC) and International Standards Organisation.

The two scenarios considered:

- Moderate (2°C) Emissions scenario – where aggressive action keeps global warming to within 2°C i.e., a world that has succeeded in implementing the Paris Agreement and is likely to keep total warming below a 2°C tipping-point
- High (4°C) Emissions scenario – where global warming continues unchecked i.e., a world where countries have failed to meet their emissions reduction pledges under the Paris Agreement.

Climate Variable	Potential Impact	Projected change in 2050		Risk Rating
		2°C scenario	4°C scenario	
Average temperatures	Rising average temperatures may increase the risk of pests and pathogens becoming established in primary growing regions.	**~0.9°C**	**~1.1°C**	**High**
Minimum temperatures	A rise in minimum spring temperature may prevent consistent bud-break and king flower production in primary growing regions.	**~1°C**	**~1.25°C**	**High**
Maximum temperatures	A rise in summer maximum temperatures may increase energy costs in postharvest sorting and distribution centres.	**~1°C**		**Moderate**
Number of hot days (>25°C)	An increase in the number of hot days in primary growing regions may increase the risk of heat stress among orchard workers.	**~75%** increase	**~95%** increase	**Moderate**
Average Rainfall	Kiwifruit vine water demand may increase with rising temperatures, impeding on fruit development in water-deprived areas.	Substantial regional and seasonal variation.		**Moderate**
Drought	An increase in the severity and frequency of droughts, especially in already dry areas, may impede on fruit development.	**100mm** increase in PED[3]		**Moderate**
Number of dry days (<1mm / day rainfall)	An increase in the number of dry days may marginally alter the risk of drought and water stress in primary growing areas.	**0-5%** Increase in dry days		**Low**
Extreme rainfall events	An increase in extreme rainfall events may marginally alter the risk of harvest losses, soil erosion, flood damage and diminish soil productivity.	**0-5%** increase in the magnitude of a 99th percentile rainfall event		**Low**
Extreme wind speeds	An increase in extreme wind speeds may see more wind damaged fruit on the vine.	**0-2.5%** increase in the magnitude of a 99th percentile daily mean wind speed		**Low**

Figure 1: Zespri physical climate risk scenario analysis and risk ratings for New Zealand growing regions. (PED = Potential Evapotranspiration Deficit)

Risk Ratings	
High	May require adaptive action in the short to medium term in order to minimise negative financial impacts.
Moderate	May require adaptive action, but uncertainties are high/ timescales long. Keep a watching brief.
Low	Little clear evidence of risk requiring adaptive action. Revisit when fresh information becomes available.

Figure 2: Risk ratings applied to assess Zespri's New Zealand climate-related risks

Temperature change

A rise in minimum spring temperatures is likely to have a greater impact on the Hayward variety, which requires more chilling. Rising average summer temperatures will increase vine water demand and may impede fruit development in water-deprived areas. An increase in the number of hot days could cause thermal stress and have negative impacts on production. Warmer temperatures are expected to lengthen growing seasons. Plants will start maturing earlier potentially exposing them to frosts. Although the number of frosts is generally expected to decline, when they do occur, their impact could be much larger than previously experienced. Frost protection will become increasingly important. Biosecurity risks are expected to increase with invasive pests and pathogens finding conditions more suitable as the climate warms.

On the flip side, warmer temperatures and longer growing seasons in some regions may result in higher quality fruit (e.g., increased dry matter) and yield. Warmer temperatures may make existing sites with sub-optimal growing conditions (colder) more favourable and alternative growing locations may become more suited to production.

Rainfall

There is less certainty about changes in rainfall because it is more difficult to model. It is changes in rainfall patterns that are more likely to impact than reduction in rainfall. Enhanced risk of dry periods and drought are considered likely and may be intensified by increasingly strict water use regulations. Under a High emissions scenario, water access is likely to become a key concern over a long-term period (30-80 years). Heavier rainfall events are expected, which could have impacts such as flooding and waterlogging of soils.

Hail

In New Zealand growing regions there is a projected decrease in precipitation (including hail) over time. However, crop damage due to large hail events has been experienced in recent times (Motueka, December 26, 2020) and remains a risk, one potentially affecting not just the current crop but future crops.

Wind & other extreme weather events

Changes in wind speed are unlikely to be severe before mid-century. However, risk of wind-rub damage may rise and should be monitored so that additional protective measures can be put in place as appropriate. There is an expectation that the frequency with which extra-tropical cyclones may impact on kiwifruit growing regions in New Zealand will increase. However, current climate change models display little uniformity in their projection of intensity, frequency or reach of these storms in coming decades.

Non-Physical Risk

Climate change does not only pose physical risks to the kiwifruit industry. The risk of tightening environmental regulations and increasing consumer concerns about unsustainable products are likely to impact more in the short to medium term (10-30 years), where the physical risks will steadily increase over a longer time frame.

The Paris Climate Change Agreement, ratified in 2016 and now signed by 194 countries around the world, set a target of limiting total global warming to 1.5°C. Over time this will likely result in increased costs for Zespri. For example, markets including the US, EU and UK are currently exploring the introduction of carbon border tax adjustments. International agreements to reduce emissions from shipping are also expected to increase international distribution costs. In New Zealand, cost increases will be imposed through changes to the Emissions Trading Scheme (ETS) and National Policy Statement on Freshwater Management (NPSFM).

As European and North American customers, in particular, increasingly choose products based on the carbon footprint and other environmental impacts of the producing organisation, this may have brand impacts for Zespri if aspects such as carbon emissions are not well managed.

Industry Response

Adapting to the physical impacts of climate change can be assessed on different levels:

- **Tactical adaptation:** This involves modifying production practices within the current system, such as using different sprays, irrigation practices, pest management strategies, or pruning practices.
- **Strategic adaptation:** A change is made to the current production system in a substantive way which may mean a change in cultivar, a change to the vine support trellising system, or the installation of netting for hail protection or shade. Zespri's assessment of new varieties in the industry's cultivar development programme considers traits related to climate change, such as greater pest and disease resistance and no reliance on bud-break enhancers.
- **Transformational adaptation:** Involves adoption of a new production system, or a change in the location of the industry. Climate change could see kiwifruit being grown in parts of New Zealand where it currently isn't because of the climate in those areas becoming more favourable for kiwifruit. Other factors like soil and water availability would need to be favourable too to support this.

see more on the horticulture industry adapting to climate change: https://www.mpi.govt.nz/dmsdocument/26788/direct

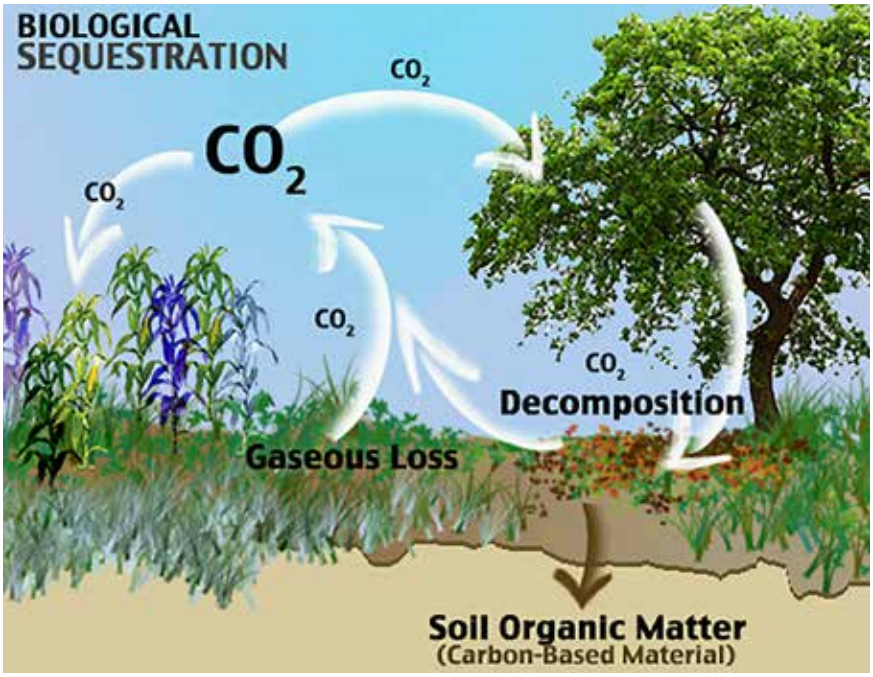
Zespri is investing more than $1 million per year in research to understand more about mitigating and managing the impacts of climate change. From assessing the carbon footprint of the Zespri Global Supply business, to understanding the water requirements of kiwifruit vines, investigating soil carbon storage, and modelling the impact of changes in weather on yield, there is commitment to taking a science-led approach to the solutions that are put in place.

Right:
Hail damage to fruit and canes, Motueka 2020.

Carbon Sequestration

This is the process by which carbon dioxide is absorbed during photosynthesis, and is stored as carbon in biomass (trunks, branches, foliage, and roots) and in the soil (Image below). Kiwifruit orchards therefore have the potential to sequester carbon in vines plus shelterbelts ("Biomass") and ultimately in the soil in the form of organic matter. This could go some way to offsetting emissions associated with producing the fruit. Research is underway to understand the amount of carbon being sequestered in NZ kiwifruit orchards.

Right:
Biological sequestration



The Role of Soil

For many growers, the health and quality of their soils is an important consideration in their management activities. Globally, health and quality of soils is also seen as important by consumers, retail customers and society. Reasons for this include the role of soil in supporting food production, filtering of water, supporting ecosystem biodiversity and function in the carbon cycle.

Storage of carbon in kiwifruit soils as organic matter occurs because of how we grow and manage our orchards. Many Bay of Plenty orchards are located on allophanic soils that, due to their chemical properties, are good at stabilising any organic carbon deposited within the soil profile. Kiwifruit vines have a root system that can explore soils at depth, and typically can turnover about 40 percent of their root mass annually. For soil carbon accumulation, this root turnover has two main benefits. Firstly, it can deposit carbon from the roots not remobilised into the plant, and secondly, the channels created by roots that have died back can provide earthworms with deeper access into the soil profile. Pergola-trained kiwifruit vines also maintain a moist soil surface over summer, allowing surface organic matter to be broken down by soil microorganisms, and digested by earthworms or washed into root channels for deeper deposition. Once deposited, this organic matter can improve water storage capacity of soils; reducing the amount of irrigation required or in some cases the need for irrigation. Soil organic matter also plays an important role in reducing the leaching of nutrients, such as nitrogen, and subsequently improving the efficiency of their use, as well as supporting microorganisms that assist in remobilising nutrients from soils for plants. As some food cultivation systems can result in the degradation of organic soil matter and soil function, it is important to be able to demonstrate to our customers the long-term sustainability of our soil resources.

FOR FURTHER READING SEE:

Soil Organic Carbon in Kiwifruit Orchards - Contribution to Carbon Footprint Analysis, Soil Health and Mitigating www.plusgroup.co.nz/downloads/SFF_SOC.pdf.

4.4.5 Agrichemical Use

Agrichemical use is required to achieve desirable production outcomes; however, agrichemicals usually have environmental and human health risks associated with their use. Zespri and the kiwifruit industry are committed to mitigating these risks and have the following processes in place to do so:

1. Zespri operates a good agricultural practice assurance programmed called ZespriGAP (based on GLOBALG.A.P.) which growers must comply with. This has a significant number of requirements that growers must meet relating to the use of agrichemicals. (For more information on GLOBALG.A.P see section 8.3)
2. Zespri each year produces a Crop Protection Standard which prescribes in detail what agrichemicals can be used on kiwifruit, when and how much.
3. Related to the above, the industry operates a "KiwiGreen" programme in which orchards are monitored for pests and if only one of the thresholds are reached can sprays be applied. This helps to minimise sprays use on orchards.
4. Those applying agrichemicals must be trained i.e. GROWSAFE approved (https://www.growsafe.co.nz/).
5. All agrichemicals used must be recorded in an online spray dairy provided by Zespri, which is audited.
6. At harvest, Zespri tests fruit for agrichemical residues to ensure fruit is free of harmful residues.
7. Zespri are investing in Research & Development to identify safer agrichemicals.

Copper Case Study

Copper, which has been commonly used in kiwifruit to control the Psa disease and to encourage natural leaf drop, is presented as a case study to illustrate the impacts associated with agrichemicals. The case study is split into three parts: a description of copper and what it is used for; copper's ecological impacts; and copper's impact on the health of kiwifruit plants.

What is Copper Used for?

Copper is registered for use on virtually all food/feed crops as a form of disease control. Copper sprays are used in many horticultural industries to protect foliage and fruit from a range of bacterial diseases. Copper is also used by some kiwifruit growers as a defoliant in autumn i.e., to accelerate leaf drop.

Successful disease control depends on both an even distribution, and good retention of the copper across all plant surfaces. Copper is most effective on those diseases that need water present to develop—such as Psa.

Copper is a bactericide, and it can kill the bacteria on contact. The copper ions travel through the cell walls of the bacteria and disrupt the cellular enzyme activity. It is non-systemic i.e., it is not absorbed or circulated by a plant; it only kills bacteria on the plant surface. As copper is a protectant, it needs to be applied evenly to the plant surface before the disease develops. It is often applied in conjunction with adjuvants that have super spreading capabilities, to allow better coverage with a lower total dose of copper.

Ecological Impacts

Small quantities of copper are necessary for the functioning of most forms of life, but to most aquatic organisms excess levels of copper are highly toxic. The main cause of copper toxicity to fish and aquatic invertebrates is through rapid binding of copper to the gill membranes, which causes damage and interferes with osmoregulatory processes. The amount of cupric ion in the environment, and its toxicity to aquatic animals through gill damage, is dependent on a number of water quality parameters including pH, alkalinity, and dissolved organic carbon.

Many terrestrial animals have the ability to cope with some amount of excess copper exposure by storing it in the liver and bone marrow. Laboratory toxicity studies have shown that exposure to high levels of copper in the diet can overwhelm the ability of birds and mammals to maintain the stability of their body's internal environment in response to changes in external conditions. However, animals which are repeatedly exposed to levels of copper (which do not cause permanent harm) may undergo enzymatic adaptation which allows them to cope with greater levels of exposure. Available data from a honeybee acute toxicity study indicated that copper is practically nontoxic to honeybees.

To reduce ecological exposures, product use labels have been amended, by way of a reduction of application rates, defining application intervals, and determining seasonal maximum application rates. Monitoring weather conditions and minimising spray drift go some way to reducing non-desirable impacts.

Plant Impacts

Copper (Cu) is considered as a micronutrient for plants. Enhanced industrial and mining activities have contributed to the increasing occurrence of Cu in ecosystems. Excess copper in the soil can induces stress and causes toxicity in plants. This leads to plant growth retardation and leaf chlorosis and/or burning. In kiwifruit vines copper toxicity often appears first in the leaves, similar to many other nutrient toxicities. Some key factors that play a role in toxicity problems are listed below:

- Using products that are not designed as agrichemicals
- Excessive chemical rates
- Tank mixing of multiple chemicals
- Poor tank agitation
- Slow drying conditions
- High temperatures during application
- An excessive use of spreader/super-spreaders at high water rates
- An excessive build-up of chemicals on leaves

Right:
Leaf speckling

Far right:
Leaf burn at the leaf margin

Right:
Bronzing of the upper leaf surface

Far right:
Brown staining of leaf veins

Growers must weigh up the risk of disease killing their vines, the risk of chemical use to the environment, and the risk of phytotoxicity resulting in small, light green leaves that cannot support the development of high yielding high quality fruit.

Zespri works closely with growers to ensure that copper, a critically necessary tool to manage Psa, is used effectively with minimum environmental impact. An upper limit is placed on the amount of copper that a grower can apply in one year and this is closely monitored by Zespri – 8 kg/ha/yr for conventional and 6 kg/ha/yr for organic.

4.5 OUR COMMUNITIES

The 2020/21 season demonstrated the collaboration the kiwifruit industry is known for. Growers, contractors and packhouses actively supported communities and families, providing jobs to locals who had lost their roles in the hospitality and tourism sectors, as a result of COVID-19, ensuring we were able to complete our harvest.

In 2020/21 Zespri donated more than 100 tonnes of fresh and healthy kiwifruit to those most in need in New Zealand and partnered with several new organisations across the country. In addition to supporting their existing community partners, they also formed new partnerships with KidsCan and Ronald McDonald House — charities which share their values and commitments.

Zespri's global offices also worked hard to assist their local communities through donations of fresh fruit and financial contributions so that hospital workers, senior citizens, young children, and those in need around the world can access kiwifruit and its high Vitamin C content.

In 2020, Zespri partnered with the Young and Healthy Charitable Trust and launched the 'Zespri Young and Healthy Virtual Adventure' programme aimed at encouraging primary aged children and their families to eat better, be more active and environmentally conscious. This online programme involves a 6-week adventure where the 20,000 participants build their own avatar and learn in fun and engaging ways why their health is important and the choices they can make themselves to protect their health and wellbeing to feel the best that they can, each and every day. The programme is supported by ASICS ambassadors Ameliaranne Ekenasio, Ardie Savea, Kane Williamson, and Samantha Charlton. Students gain points through healthy behaviours to move around a global course, virtually visiting countries like Japan, Italy, Peru and Croatia.

See: https://www.youngandhealthy.org.nz/

The programme ran again in 2021, and as part of the adventure Zespri also organised a community day for more than 600 children and their families at Papatoetoe South Primary School, as well as five events across the North Island to surprise 130 children with brand new ASICS shoes. This programme is having a real impact on the lives of young people around New Zealand, teaching them habits which will help them lead healthier, more active lives.

Right:
Katikati Primary School Students at the launch of the Zespri Young & Healthy Virtual Adventure at their school.

4.6 BIOSECURITY

As an island nation, New Zealand has a unique ecosystem as our native species evolved without any natural predators. The arrival of new species, including humans, has disrupted the balance many times. The introduction of pests and diseases remains a continual threat to our economy, environment, and way of life.

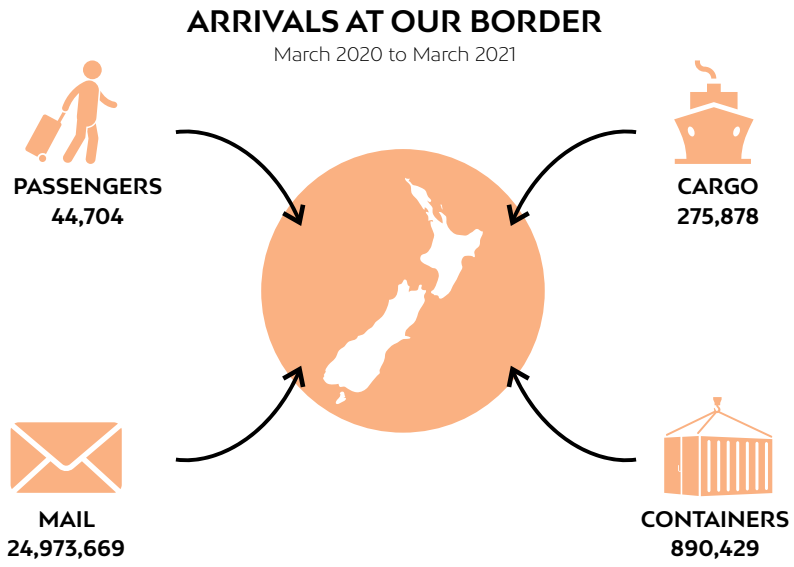
Biosecurity in New Zealand is not a single line of defence at the border, rather it is a multi-layer system that begins offshore (including international and trade agreements and treatment offshore), incorporates the border interventions, and continues post-border. Here it becomes a joint effort with action and measures taken by central and local government, industries, the science community and others. These post-border activities include surveillance for early detection of new pest incursions; readiness and response actions when a new pest is detected; and on-going pest management to contain or reduce the impact of pests that have become established.

Kiwifruit Vine Health (KVH)

KVH is a leading biosecurity organisation, dedicated to supporting the New Zealand Kiwifruit Industry. They were established in December 2010 to lead the industry response to the Psa incursion. Since November 2012, KVH has been the lead organisation responsible for managing all biosecurity readiness, response, and operations on behalf of the industry. KVH works collaboratively with kiwifruit growers, NZKGI, Zespri, the postharvest and associated industries such as beekeepers, pollen providers, nurseries and contractors, and Government, particularly the Ministry for Primary Industries (MPI).

Investment in Science to understand the nature of significant biosecurity threats, and developing tools for their management should they arrive, is a big priority for the industry. KVH and Zespri have already invested over $16 million in Psa research and innovation to understand how to manage the disease and are looking to invest more in research for other biosecurity threats.

See: https://kvh.org.nz/



KIWIFRUIT'S MOST UNWANTED

Kiwifruit Vine Health (KVH) undertakes readiness and response planning to minimise the impact of future biosecurity incursions to the kiwifruit industry.

The following organisms are considered the highest risk to the kiwifruit industry, based on the likelihood of them getting here and establishing; and the potential production and market access implications should this occur.

Our next incursion won't necessarily be an organism on this list however. We all need to be on alert for any unusual pests or plant symptoms and maintain on-orchard biosecurity best practice ALL the time.

FRUIT FLIES

Queensland, Oriental, Mediterranean

- High likelihood of entry – have crossed our borders many times.
- Production impacts for a range of horticultural crops, but considered low for kiwifruit.
- Severe market access restrictions, particularly for Queensland Fruit Fly which is not present in most major kiwifruit markets.

Risk Months: Sep – June
I can enter NZ hiding on:

BRAZILIAN WILT

Ceratocystis fimbriata

- Soil-borne pathogen causing damage to kiwifruit in Brazil – reports of up to 50% vine loss.
- Vine death can occur extremely rapidly after expression of symptoms. Hayward on Bruno rootstock also affected.
- No known effective treatments.
- May be eradicable with good biosecurity practices and if detected early.

Risk Months: Year Round
I can enter NZ hiding on:

BROWN MARMORATED STINK BUG

- Pierces kiwifruit resulting in fruit drop and rot. Fruit loss is typically 5-10% but up to 30% on worst blocks.
- Extremely difficult to eradicate – early detection is essential.
- Major nuisance pest overwintering inside houses in huge numbers.
- High likelihood of entry as a hitchhiker on shipping containers, cars, machinery and luggage.

Risk Months: Sep – Apr
I can enter NZ on:

SPOTTED LANTERNFLY

- Attacks over 70 host species, including kiwifruit - eradication efforts overseas have been unsuccessful.
- Production impacts from extensive feeding resulting in oozing wounds, wilting, and sooty mould growth, which can be prolific.
- Hitchhiker pest that is hard to control – tends to fly out of ochards when sprayed and return later.

Risk Months: Sep – May
Look out for my eggs on:

PSA NON NZ STRAINS

- NZ has one form of Psa – others exist internationally and could cause severe impacts if they get here.
- Psa in Japan and Korea appears to be more virulent to Hayward than the NZ form of Psa.
- New Psa strains could be more virulent to 'Psa tolerant' cultivars.
- May be difficult to distinguish from "common" Psa so best practice is not to spread any form.

Risk Months: Year Round
I can enter NZ hiding on:

WHITE PEACH SCALE

- Regularly intercepted on imported fruit. Therefore no imported fruit should be taken on to orchards as a precaution.
- Up to 20% production losses reported on Italian orchards.
- NZ envrionment considered favourable for establishment.

Risk Months: Nov – Mar
I can enter NZ hiding on:

VERTICILLIUM WILT

- In susceptible kiwifruit cultivars infection always leads to plant death, which occurs suddenly.
- Many strains worldwide – only Chile has reported a strain virulent against kiwifruit.
- Good biosecurity hygiene practices are essential to manage spread of this soil-borne pathogen.

Risk Months: Year Round
I can enter NZ hiding on:

INVASIVE PHYTOPHTHORAS

- Known as the plant killers – a group of significant plant pathogens and a major threat to all plant sectors.
- Species have caused significant impacts to kiwifruit offshore. Many other known and unknown species could also cause impacts under certain conditions.
- Easily spread, particularly with plant material movements.
- Can spread in plants showing no symptoms.

Risk Months: Year Round
I can enter NZ hiding on:

For more information about these organisms and other biosecurity threats to the kiwifruit industry, see the fact sheets on the KVH website at **www.kvh.org.nz**

CATCH IT SNAP IT REPORT IT

TO REPORT UNUSUAL PESTS OR DISEASES

CALL THE MPI HOTLINE 0800 80 99 66 OR KVH 0800 665 825

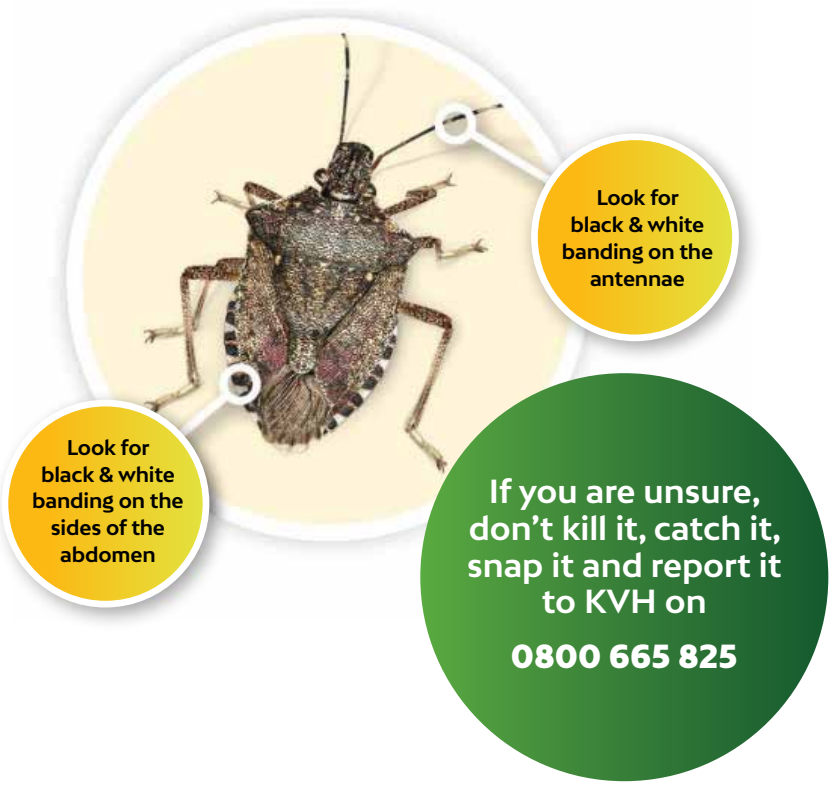
4.6.1 Case Study: Brown Marmorated Stink Bug

The Brown Marmorated Stink Bug (BMSB) is native to parts of Asia but has been invading North America, Europe and Chile in recent years. The risk of it entering New Zealand is considered extreme. The high-risk season for incursions is September through to April, and in the 20/21 season there were 48 live BMSB finds - most at the border where they were found on imported equipment, but also in parcels.

BMSB can hitchhike on inanimate objects such as cars and shipping containers from Asia, USA and Europe. There are currently 37 countries from which incoming goods (e.g., vehicles and machinery) must be treated before they arrive in New Zealand. If BMSB were to enter the country, it would have no problem establishing due to New Zealand's highly suitable climate and abundance of host material. Its entry and establishment would result in significant production impacts to many horticultural industries. Kiwifruit is a host species and BMSB feeding results in fruit drop and postharvest rot. Anecdotal reports (based on evidence in Italy) suggest fruit loss could be up to 30% on some kiwifruit orchards.

Identification

There are many other species of stink or shield bugs found in New Zealand that could be confused with BMSB. However, BMSB are larger than the other shield bugs (14-17mm). The banding on the side of the abdomen and on the antennae are characteristic. BMSB emits a pungent odour when disturbed.



The white or pale green cylindrical shaped eggs are laid on the undersides of leaves in clusters of about 25. The eggs are only 1mm in diameter but become apparent when nymphs emerge as they stay with the egg mass for several days. Nymphs are brightly coloured with black and white banding on legs, dark reddish eyes and yellow-reddish underbelly with black stripes.

Signs and Symptoms

BMSB feed on a wide range of plants with seeds or fruit including ornamental plants and vegetables. They pierce the outer surface of the fruit and suck out juices while injecting saliva, which causes dimpling on the fruit's surface and rotting and corking of the flesh. Adults are mobile and readily move from plants with early ripening fruit to ones with later ripening fruit. They seek shelter in houses/protected areas in autumn/winter. Egg masses and nymphs may be seen on the undersides of leaves.

Right:
Nymph and egg mass

Far right:
BMSB feeding damage on an apple

Distribution and Climate Range

BMSB is now present across three major continents. It is native to Asia and found in China, Japan and Korea. In 1996 it invaded the USA where it has been found in 44 states and four Canadian provinces. In 2007, it was detected in Switzerland and 13 countries across Europe are now reported to have established populations. BMSB has been found in Santiago, Chile, the first population in the Southern Hemisphere. This potentially increases the risk to New Zealand given our seasonal alignment.

Right:
BMSB distribution shown in red

Figure 3. Distribution of BMSB (in red)

Control

Eradication of BMSB is extremely difficult and early detection is crucial for success. While traps are available for monitoring, these are not suitable for use in a surveillance network for early detection, like we have for fruit fly. Therefore, public reporting of suspect finds is critical.

Insecticides may be an important tool in an eradication attempt but are unsuitable for long term management given the residue issues that would be associated with repeat applications at high dosage rates. The most promising tool for BMSB management in New Zealand – if BMSB were to establish – is a parasitoid known as the Samurai Wasp, which is capable of parasitizing over 80% of BMSB egg populations. In August 2018, the EPA (Environmental Protection Authority) granted approval for the release of Samurai Wasp if BMSB establishment occurs.

Right:
A Samurai Wasp (the size of a poppy seed) making its way out of a BMSB egg.

"Insecticides may be an important tool in an eradication attempt but are unsuitable for long term management given the residue issues that would be associated with repeat applications at high dosage rates."

4.6.2 Industry Response to Psa

***Pseudomonas Syringae* pv. *Actinidiae*, (Psa or Psa-V)**

Psa is a bacterial disease that can kill kiwifruit vines. It carries no risks associated with human or animal health and does not affect plants other than kiwifruit vines. It was discovered for the first time in New Zealand on a Te Puke kiwifruit orchard in November 2010. Since then, Psa has spread rapidly and now 93% of New Zealand's kiwifruit hectares are on an orchard identified with the disease.

Psa can spread rapidly through weather events, namely wind and rain, and the movement of plant material. It can also spread through unclean footwear, vehicles, machinery, and orchard tools. Psa thrives in wet, humid conditions; and multiplies quickly in wet conditions. Therefore, spring and autumn are high-risk periods for Psa to spread. The disease slows down in warm, dry conditions like summer.

In an orchard Psa can exist as:

- An epiphyte, living on plant surfaces without causing high levels of infection; and/or
- As an endophyte, living within the vine, having entered through natural plant openings or man-made wounds—resulting in severe infection.

Growth of the bacteria outside/inside the vines can result in leaf spotting, cane/leader dieback and, in extreme cases, vine death accompanied by the production of exudates.

Right:
Psa magnified 6000 times (KVH)

Far right:
Psa is rod shaped with flagella (KVH/ Plant and Food research)

Right:
Leaf spotting symptom of Psa (KVH)

Far right:
Exudate (ooze) coming from a kiwifruit plant is another symptom of Psa (KVH)

The outbreak of Psa in 2010 was a severe blow to the kiwifruit industry. The industry was seriously questioning its future as the vine killing disease rapidly spread and growers watched helplessly as entire orchards were removed. The greatest impact from Psa was felt in 2013/14 when grower payments were down 17 percent due to a 55 percent reduction in volumes of Gold kiwifruit. However, the focus of conversation about Psa among industry and government bodies nationwide today is more about the industry's remarkable recovery from it, rather than its grim history.

The success of the industry's recovery has been a combination of many factors but is underpinned by the replacement of the highly susceptible Hort16A variety, with the more Psa-tolerant Gold3 variety. Through a combination of research and development, grower innovation, and by banding together to share knowledge, an enormous amount of information has been discovered about the disease and how best to manage it.

Growers now have several tools and best-practice techniques available to them to help manage the disease and remain profitable in a Psa environment. This section will outline some of the initiatives and actions put in place by industry to bring the industry back from the brink of devastation and onwards to new levels of success.

Innovation - the Development of Psa Tolerant Cultivars

Plant & Food Research is the sole research provider to the New Zealand Kiwifruit Research Consortium, jointly funded by the Ministry of Business, Innovation and Employment (MBIE) and Zespri. Together they are developing new cultivars of superior quality that command a market premium, with a focus on taste, novelty and convenience. Additionally, new cultivars are bred with tolerance to diseases, including Psa.

In 2021, Zespri and Plant & Food Research launched a 50:50 joint venture named the Kiwifruit Breeding Centre. The Centre will be based in Te Puke, with a focus on driving greater innovation within kiwifruit breeding, creating healthier, better-tasting and more sustainable varieties. The organisations will share royalties from any future commercialised new varieties.

See: https://www.plantandfood.com/en-nz/article/new-kiwifruit-breeding-centre-driving-greater-innovation-to-commence-in-2021

Research and Development Programme

KVH and Zespri Innovation run a global research and development (R&D) programme into Psa. The programme was established in early 2011 and has enlisted the best scientific minds globally to provide solutions for Psa. The Innovation team partners with around 20 global researchers to provide the best available expertise to the New Zealand kiwifruit industry. The programme includes product testing to identify, rigorously test and get permission from MPI to use suitable products to help manage and control the spread of Psa. To date, more than 300 products have been tested for efficacy against Psa.

See: https://www.kvh.org.nz/Psa_RD

National Psa Pest Management Plan (NPMP)

The NPMP was established in May 2013 to prevent the spread of Psa-V and minimise its impacts on kiwifruit production. Key elements of the plan involved movement controls, monitoring, reporting, incursion response and managing the disease, along with a continued focus on awareness, education and research. KVH review the Operational Plan for the NPMP on an annual basis and make changes as necessary to ensure the NPMP objectives continue to be met.

As time has moved on the situation has changed. The focus of the plan on preventing spread has changed, with only the South Island and Far North still Psa-V free. There is now more emphasis on new Psa-V biovars (strains) that have and will continue to arise, including strains resistant to current chemical control tools. New kiwifruit varieties need to be monitored for tolerance to Psa in orchard environments. KVH have established protocols for controlling the movement of risk items, which differ depending on the nature and level of risk these items pose.

See: https://www.kvh.org.nz/KVH_Protocols

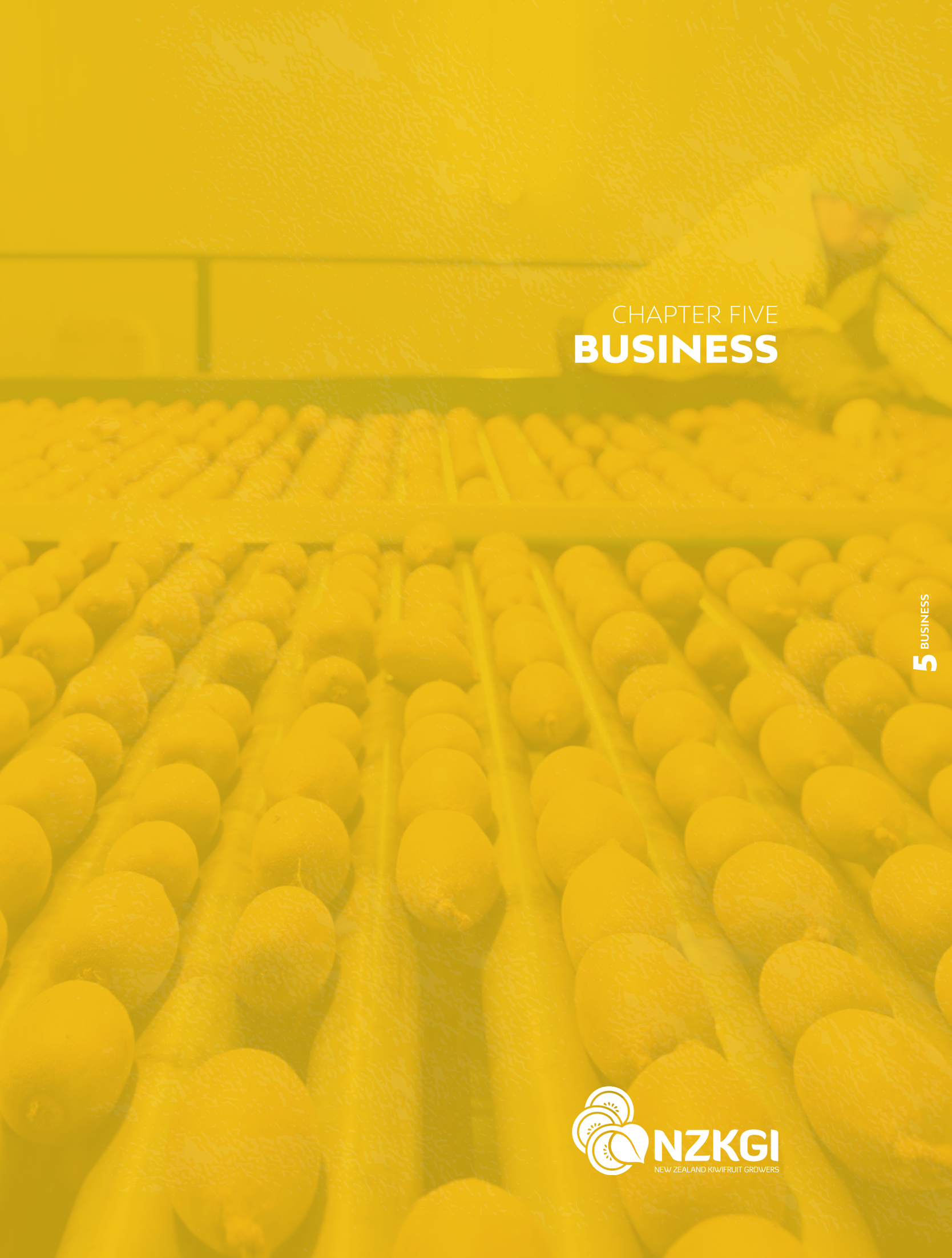
GIA (Government Industry Agreement)

The importance a collaborative, coordinated response to biosecurity incursions is one of the biggest lessons the kiwifruit industry learnt from the outbreak of Psa in 2010. Since then, there is a more engaged biosecurity relationship with government and increased capability to respond thanks to the formalising of the Government Industry Agreement for Biosecurity Readiness and Response (GIA) Deed (signed in 2014), and Operational Agreements (OA) for specific threats.

GIA commits the kiwifruit industry to work with government and other primary sector industries to improve readiness for future biosecurity events, and jointly respond to future outbreaks. What makes the GIA concept so important to the kiwifruit industry is that it enables industry and government to achieve better biosecurity outcomes through the work undertaken jointly. Because decision making, costs and responsibilities are shared, all partners can have the confidence that the best decisions are being made about managing biosecurity – there isn't just one group making the big calls.

GIA was put into action in 2019 when KVH and other horticultural industry groups worked in partnership with the Ministry for Primary Industries (MPI) to respond to detections of fruit flies in three Auckland suburbs. The responses set up in Otara, Northcote and Devonport ran well under the GIA partnership, following the pre-agreed operational plans established and tested in previous responses. By being involved in decision-making processes, KVH was able to ensure the interests of New Zealand's kiwifruit growers were represented fully. Between mid-February and mid-November 2019, the kiwifruit industry contributed 43 people and 540 staff days to the response, assisting in operational activities that included surveillance, fruit collection, baiting, and public awareness.

> "KVH and Zespri Innovation run a global research and development (R&D) programme into Psa. The programme was established in early 2011 and has enlisted the best scientific minds globally to provide solutions for Psa."



CHAPTER FIVE

BUSINESS

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER FIVE
BUSINESS

This chapter covers a range of topics that come underneath the commercial umbrella. Firstly, chapter 5.1 examines Zespri's brand and marketing and includes information on the supply and demand of kiwifruit. Chapter 5.2 and 5.3 provides detail around Zespri's unique standards and practices and chapter 5.4 gives readers a lesson on orchard accounting 101.

THE SECTION IS DIVIDED AS FOLLOWS

5.1 ZESPRI'S ROLE IN THE INDUSTRY: MARKETING AND INNOVATION

Zespri is acknowledged as a category leader in kiwifruit, managing around 30 percent of globally traded volume. Zespri has built a strong reputation through:

- Delivering high-quality, healthy kiwifruit to consumers around the world.
- A focus on innovation to develop new varieties, increase productivity and introduce new, more sustainable growing techniques.

- Developing advanced supply chain systems to distribute premium quality kiwifruit around the world.
- Researching the health benefits of kiwifruit with credible research partners to better inform consumers and drive sales.
- Establishing strong brand awareness and in-market service.
- Working to understand what consumers want to allow us to make data-driven decisions to meet their needs.
- A commitment to helping people, communities, and the environment to thrive through the goodness of kiwifruit.

Zespri's long-term strategy sits under four pillars that set out the company's enduring strategic priorities. The four priorities are described below:

1. **Delight Customers**
   Zespri aims to grow demand for their premium brand by building trust with their consumers and customers and placing them at the heart of everything they do.
2. **Optimise Performance**
   Zespri aims to optimise productivity and performance right across their business to deliver the world's best kiwifruit every day in the most efficient way they can.
3. **Better Tomorrow**
   Zespri will develop new sources of value, improve their business for the long-term, and lead sustainability in their industry.
4. **Thrive Together**
   Zespri will invest in their people, protect their safety and wellbeing, and leverage their diversity to unleash Zespri's full potential.

5.1.1 Brand

2020 saw Zespri's first brand refresh in more than 20 years, launched at the international fresh produce exhibition Berlin Fruit Logistica. The major and visible part of the rebrand is the new logo. Customers and consumers see a refreshed Zespri logo featuring the use of a green fan, inspired by the vibrant cross-section of a kiwifruit with different shades of green bursts, and a red wordmark reflecting the energy and dynamism of the Zespri brand. It is said to capture the burst of flavour consumers get when biting into a Zespri Kiwifruit.

Zespri Chief Growth Officer Jiunn Shih says the refresh was designed to position the company for its next phase of growth. "We're confident that our new brand will resonate not only with our loyal fans but pique the interest of new ones, helping differentiate Zespri in the fresh produce market so that we can continue to grow our share of the global fruit bowl," In launching the new brand identity, Zespri were clear that they were fruit on a mission, in a bid to help consumers *make their healthy irresistible*. The investment in the brand was $15 million.

Watch: https://www.youtube.com/watch?v=7LOQp7wV6qo

Zespri also redeveloped their Class 2 sub-brand Zespri Vita. As with the main brand, it is designed to improve brand recognisability, with a view towards building stronger emotional connections with consumers, particularly those looking for healthier options. The Class 2 range Green and SunGold is mainly exported to South America and South Africa, and is sold in the New Zealand market.

The Zespri Vita story:

We are grown from the land, ripened by the sun and hand-picked with care. That's us. Delicious inside, but uniquely distinct on the outside, just like most families. Coming in different shapes and sizes, we're proud to bring to our consumers our irresistible natural goodness, from our family of growers to theirs. So cheers to our irresistible future, from our family to yours!

5.1.2 Marketing

In the 2020/21 financial year, growers through Zespri invested NZ$167 million in marketing, representing approximately 5.4 percent of sales revenue. This was a decrease from $171m in 2019/20. The small decline was a result of marketing efficiency coupled with the impacts of COVID-19, which reduced activities like fruit sampling.

Despite the significant challenges that COVID-19 posed to everyday business across all markets, the Zespri teams globally continued to drive efficiency and effectiveness with fewer campaigns, bigger impact and better results. All the campaigns have showcased the Zespri brand in a consistent manner, underpinned by a global visual identity and the tagline that with Zespri you can *"Make your Healthy Irresistible"*.

The total number of global campaigns was reduced from 10 in 2019 to six in 2020. 86 percent of global sales value was covered by just two campaigns – the expansion of Kiwibrothers to cover Japan, Korea, Vietnam and Europe and Vitamin C Goldmine campaign across Greater China.

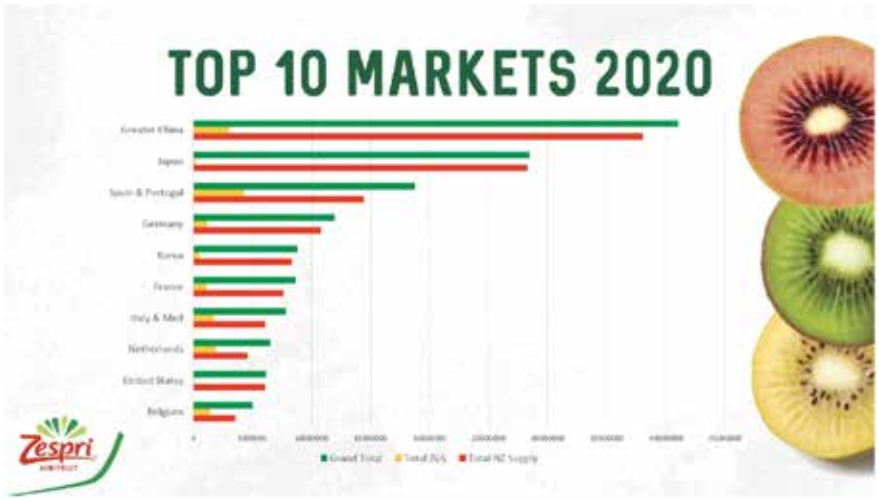
Watch: https://www.youtube.com/watch?v=RiogWDYi7Vc
https://www.youtube.com/watch?v=Jatp9bcBAWs

The Zespri brand's bigger impact was demonstrated by winning eight awards in Japan, US, and Greater China, as well as the Grand Prix at the ACC Brand Communication, being the no. 1 rated TV commercial amongst 12,411 creatives for the year and winning a prestigious EFFIE award in the US for marketing effectiveness in the Commerce and Shopper Challenger Brand solutions globally. They were also recognised by commercial partners in Hong Kong where Zespri won the Park n Shop super brand award and the 20 years' best strategic partner award from Yonghui in China.

With consumers suddenly spending more of their time online for entertainment and grocery shopping, much of the traditional media focus was diverted to online platforms, engaging with consumers where they were looking for information and inspiration. Zespri saw a significant shift in consumer's needs, interests and requirements towards nutrition, and specifically boosting their immunity. Zespri also responded through key messages which highlighted the superior Vitamin C content in kiwifruit.

Better results were seen in a clear upward trend of Zespri Kiwifruit sales across our key 15 markets, with significant increases in Taiwan, Japan, Korea, Singapore, Vietnam, Spain, Germany, France and the Netherlands compared to 2019. 2020/21 saw a continued increase in the number of markets where Zespri is the number one fruit brand, based on Kantar Brand Power rankings, up from 2 to 3 in the last year, and similarly in 2020/21 Zespri are in the top 3 fruit brands in 10 of our markets, up from 9 last year. Similarly, Zespri have seen an increase in the percentage of our key markets in which their brand is strong enough that consumers are willing to pay a premium for our great tasting fruit. In 2020/21, 80 percent of our key markets had a brand premium over the market average, up from 71 percent last year.

While the fruit category returned to growth across our core markets, Zespri growth also significantly outpaced the total category, up 14 percent in global sales compared to 3 percent for the broader fruit category. The category's growth can certainly be attributed to the global rise in health concerns caused by the global pandemic. While Kiwifruit's growth can also be explained by the strong association with health and fitness, the Zespri brand has gained standing from significant improvements in a number of health-related image attributes versus last year as a result of their brand campaign.



Understanding Consumers and Health Communications

Health is a key part of Zespri's brand strategy. Promoting the health qualities of kiwifruit is an increasingly important part of Zespri's strategy to increase sales and be top-of-mind for consumers. In an early study done by Zespri, health was identified as one of the top three factors for creating a differentiated brand in Zespri's top 13 markets, along with taste and quality.

Zespri has researched the health benefits of kiwifruit for many years, and recently, these findings were overlaid with what consumers felt is important. This determined Zespri's health marketing strategy. The diagram below summarises the health benefits of kiwifruit into three pillars. Each pillar represents a proposition that has scientific evidence of a health benefit, as well as being important in the minds of consumers, which in turn is a reason why they'd purchase kiwifruit. For more on the health benefits of Kiwifruit see Chapter 4 Science and Sustainability.

Below:
The three health communications pillars within the Zespri healthy strategy

Product Attributes and Health Benefits of Kiwifruit

- The Three Health Communications Pillars within the Zespri® Health Strategy -

Proposition:	Digestive Health		Vitamin C Health	Nutrient Rich				
	← Nutrient Rich			→				
Product Attributes of Kiwifruit:	Actinidin	Fibre	Vitamin C	Low GI	Anti-ox, vit C, E	Folate	Potassium	Phyto-Nutrients
Associated Health Benefits:	Digestive health benefits upper digestion comfort	bowel comfort laxation	Vitality / Wellbeing Immunity Beauty	blood sugar mngmt / diabetes	contains	natural source pregnancy	contains muscle function	contains

5.1.3 Market Development Strategy

To maximise the results and efficiency of investments across the markets, Zespri created the Market Development Framework. The framework segregates its key markets by their stage of development. The four stages of development are: **Explore, Launch, Establish** and **Enhance**. This helps the business to determine the appropriate level of investment based on the market's stage of development.

At the **Explore** stage, every market is unique and has different requirements but is generally in the early stages of development. The primary focus is on building distribution and penetration (bringing new users into the category). Zespri selects the most promising markets to promote into the **Launch** stage and these markets become a priority for the business in terms of supply volume, portfolio split and marketing investment. Currently USA is the only market in the launch stage, with Vietnam set to move up in the future. As markets continue to grow and develop, the focus shifts to increasing penetration and usage **(Establish)** and emphasising consumer benefits to enable a greater premium and increase consumption frequency (**Enhance**).

5.1.4 Supply and Demand of Kiwifruit

Zespri's sales and marketing investment works to create demand ahead of forecast supply. Keeping demand ahead of supply enables Zespri to sustain value at all stages of their value chain. Zespri builds strong 'win-win' relationships with its customers to ensure Zespri product is available in market, with great instore visibility for their consumers to buy. In addition, strong and sustained market returns are essential for growers, post-harvest operators, and Zespri in order to support and encourage the collective supply investment required.

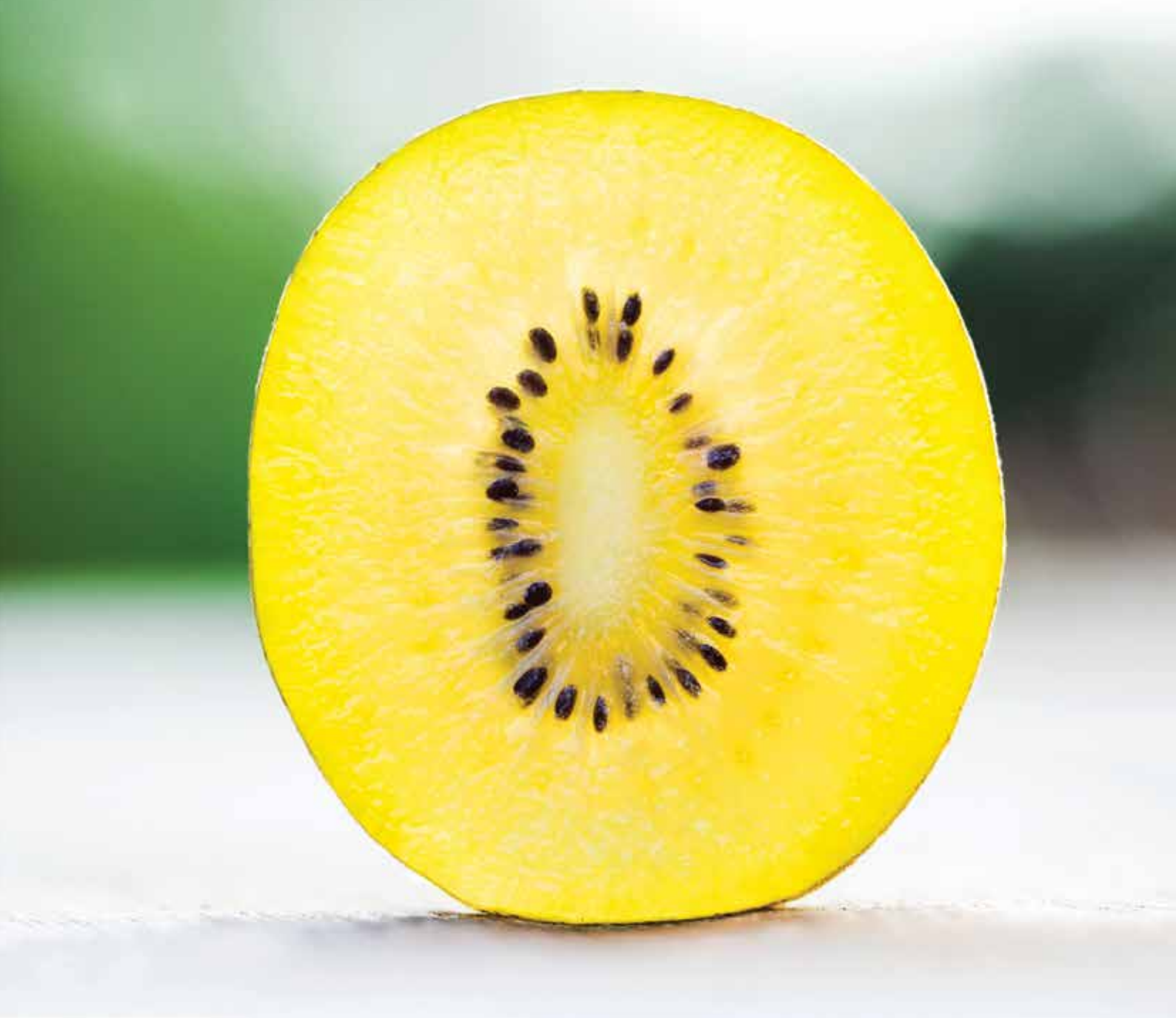
Kiwifruit is still an underdeveloped category within the fruit bowl, making up around 0.7 per cent of total fruit sold, but with huge growth potential. This means there are opportunities for growth and advantage to be gained through scale. However, with growth and success also comes competitor risk. Below are some other factors that may affect or impact the supply and demand of kiwifruit:

Supply

- Production of kiwifruit in New Zealand is seasonal, so to maintain market share in an increasingly competitive market Zespri works to ensure 12-month supply by growing fruit in offshore regions such as Italy, Greece, France, Japan and South Korea (Zespri Global Supply or ZGS).
- Adverse weather such as frost, cyclone, drought, etc which affect crops and can impact the yield of Class 1 product and the size profile of each season's crop.
- Biosecurity incursions.
- Regulatory changes which restrict the industry's ability to grow.
- Food safety/contamination risks.
- Labour constraints.

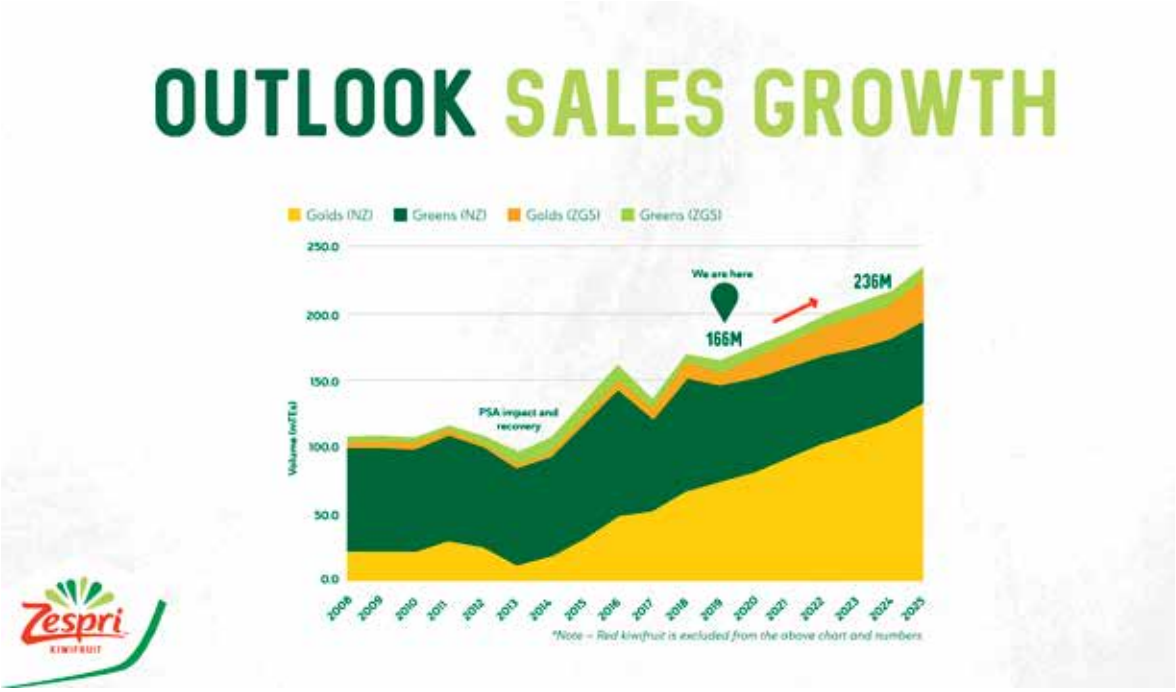
Demand

- There are varying levels of economic recession (stemming from COVID-19).
- Markets cannot develop at the expected rates, lowering return on investment and potentially delivering lower profitability than planned.
- Market access is lost to a significant market.
- A significant new competitive gold variety emerges to compete with Zespri.
- A new competitive fruit takes market share from all other fruits.
- Organic supply cannot be increased, leaving a gap in Zespri's product offering.
- There is a crop increase in excess of market capability.
- Supply is unable to meet the quality and delivery requirements of markets, particularly in taste standards and larger size profile that provide points of differentiation.
- Consumers move away from whole fresh kiwifruit as the need for convenience increases.



In 2020/21 Zespri sold 181.5 million trays of kiwifruit, an increase of 10% from the 164.5 million trays (3.6 kilograms per tray) the year before. As the graph below shows, Zespri has a confident view of demand and aims to produce 263 million trays by 2025, which would help Zespri achieve their goal of $4.5 billion in sales by 2025. Zespri's challenge is to develop demand ahead of supply to maximise returns to growers. Notably, the dip in production in the graph below during 2011-2013 shows how crop volumes were impacted by the bacterial disease Psa-V. This shows the importance of crop protection, innovation and biosecurity to the industry.

Below:
Forecast volume growth by category, forecast supply volumes to 2025



Around 87 percent of Zespri Kiwifruit is grown in New Zealand, and about 13 percent offshore. It is expected that the production in both hemispheres to increase, though New Zealand supply will remain by far the largest. To maintain value, as production increases so must demand. Long term demand forecasts are developed to inform production requirements to help ensure supply does not outpace demand.

Looking Ahead - Opportunities to Increase Demand

Market development - Identifying and developing new markets, in a way that allows Zespri to activate them strongly, while continuing to grow existing markets.

Strengthening relationships within existing markets - Strengthening relationships with key customers and focusing on performance in prioritised markets. For example, from a position of strong overall demand creation and strong consumer acceptance of SunGold, Zespri is looking to continue to develop its position in China – a vitally important market. Further, Zespri is investing to build its position in the USA as another major market.

Strong go to market strategies - To ensure all appropriate channels and opportunities can be reached and serviced. This is supported by win-win-win relationships with the distribution partners as well as effective joint business planning.

An increase of organic production - Organics are an opportunity for all varieties, with potential to grow in many markets as consumers demonstrate a need and a willingness to pay more.

Strong marketing campaigns - Zespri's sales and marketing strategy is focused on ensuring consumers are at the heart of their campaigns and through using a "think global, act local" approach, Zespri ensures that all communication and activities are relevant for local consumers.

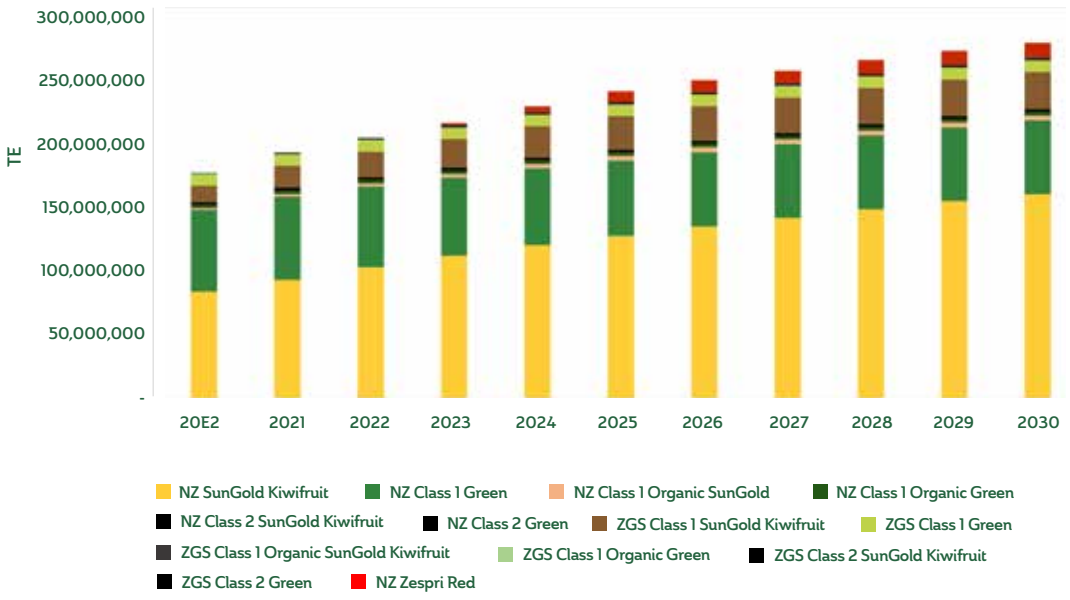
Innovation - Through developing new cultivars, protecting fruit from pest and diseases, sustainable orchard productivity and optimising how to deliver customers with high-quality fruit.

Zespri's 10-year Overview of Supply and Demand

Zespri has been developing a 10-year view of supply and demand. The purpose is to set out an optimal view of sustainable growth over the very long term, with an aim of balancing volume growth with preserving value.

Below is a graph demonstrating the level of volume Zespri believes it may achieve over the next 10 years. The graph shows that growth over the next 10 years is likely to be driven by SunGold, with an increase in supply from New Zealand sustainable at around 10 million trays per year. It is important to note that this graph is not a forecast, and the volume growth is subject to change, and the ranges are wide, recognising a number of factors. For example, returns for SunGold in the short-term are expected to remain strong as demand outstrips supply but expected to moderate in the longer term as volumes come on. Further, Green in the short term is still potentially subject to swings in volume which will impact returns.

12-MONTH, 10-YEAR TARGET DEMAND VOLUME GROWTH



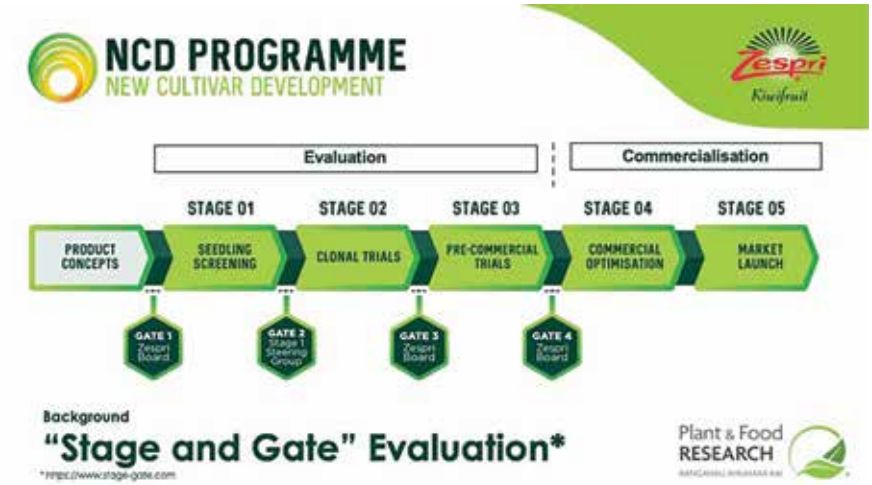
5.1.5 Innovation

Zespri is committed to creating healthier, better tasting and more sustainable varieties, and extending Zespri's position as the world's most innovative and successful kiwifruit exporter.

Zespri's innovation investment covers five platforms:

- Develop new cultivars – with the intention of developing better kiwifruit cultivars faster
- Protect supply – to deliver sustainable pest and disease control and fruit safe to eat
- Improve sustainable orchard productivity – to produce a premium crop on every orchard
- Optimise sustainable supply chain delivery – to deliver the optimal eating experience
- Create knowledge for value add – increase users and usage in markets through tailored communications e.g., health and nutrition

Right:
Zespri and Plant & Food Research 'Breeding Pipeline'



Following years of extensive research by Zespri and Plant & Food Research (PFR), along with rigorous trials through orchard, supply chain, and market phases, in 2022 RubyRed (Zespri Red) will move from a trial environment to the onset of commercial orchard production from the first of the 150 hectares licence that were released back in 2020. The Zespri Red concept has been in development for more than 20 years, with the original Red19 seedling first planted at the Kerikeri Research Centre in 2007.

Interest in the Zespri Red variety among growers, customers and consumers is strong and there is ongoing research to improve fruit quality and firmness, and storage. Indications from sales trials are that RubyRed, with its unique colour profile and berry-like taste, is bringing new and younger consumers into the category. RubyRed has also been selling at a premium over Zespri SunGold Kiwifruit in all trial markets. The variety has a shorter shelf life than SunGold or Green, so Zespri have prioritised their Asian markets given the shorter shipping times. In 2022, It will be available in commercial volumes in New Zealand, China, Singapore, and Japan.

Last year Zespri explored research on harvesting SunGold Kiwifruit earlier and they're considering new possibilities for the Taste Zespri Programme. Knowledge on how to utilise Controlled Atmosphere (CA) storage to extend the packing window of SunGold Kiwifruit as volumes increase, without compromising fruit quality outcomes, has been expanded. This is through research trials and Post-harvest Innovation Fund trials (Zespri partnering with packhouses), which has built confidence in this approach. In 2020/21, 2.4 million trays of Zespri Green went through CA across the industry (up from 0.5 million trays in 2019, and 0.02 million trays in 2018).

There have been increased research efforts into the immunity benefits of SunGold Kiwifruit with two projects underway assessing the beneficial impacts SunGold Kiwifruit have on immune endpoints. They are both human clinical studies that will measure how inclusion of two Vitamin C-rich SunGold Kiwifruit to our diet per day impacts our immune system.

Zespri have made significant investment in a pan-industry, government funded Primary Growth Partnership programme called 'A Lighter Touch'. The objective of this programme is to support agroecological crop protection for the New Zealand horticultural sector which will be a step change in pest management, balancing improved productivity with a lighter touch on the environment. This is well aligned with Zespri's sustainability goals for climate resilience and guardianship of the land for future generations.

Further progress has also been made in the Digital Crop Estimation (DCE) programme with Innovation support to add a fruit sizing component to the crop counting model.

5.2 ZESPRI'S ROLE IN THE INDUSTRY – STANDARDS

Zespri focusses on being able to supply consistently high quality, great tasting fruit throughout the season, in a safe and sustainable way. The size, appearance, and taste of the fruit is driven by what the consumer wants and then what growers are realistically able to achieve through modifying their orchard management practices, underpinned by research. Size and Taste are the key drivers of value for Growers OGR. Zespri sets the standard for each of the quality requirements described in this section:

- Fruit Size (Section 5.2.1)
- Taste (Section 5.2.2)
- Internal Colour (Section 5.2.3)
- Appearance (Section 5.2.4)
- Traceability (Section 5.2.5)
- Chemical Residues (Section 5.2.6)

5.2.1 Fruit Size

Fruit sizes range from size 16 to size 42. "Size" of fruit is relative to weight range which translates into how many fruit fit into a 3.6kg tray e.g. size 18 means that 18 fruit can fit into a tray. Gold3 fruit that is smaller than size 36 and Green fruit that is smaller than size 42 is considered to be non-standard supply (NSS). Zespri sources limited volumes of NSS fruit with the remainder of small fruit being sold on the local market, processed or used as animal feed.

It is important that fruit size matches consumer demand. Fruit is sized by weight. The size profile of each cultivar is quite different. Gold3 tends to grow quite large while Zespri Red is much smaller. Different markets and different customers have different size preferences. It is important that growers produce a range of sizes to meet this demand. Market demand for very large and very small fruit is limited. The table to the left of the page shows the average size of fruit the market prefers for each cultivar.

Zespri continues to stress that for all varieties, especially Gold3, focus must be on taste over yield. In this variety larger fruit from an orchard usually have higher dry matter which means it tastes better. Growers need to be aware that some fruit sizing tools, such as biostimulants, can increase fruit size but tend to lower dry matter and may in fact be counter-productive in improving taste. Market signals are received by growers by the income they receive for their fruit. Growers will modify their orchard management practices to maximise the amount of fruit they produce of the preferred size profile and taste which in turn increases their fruit payments.

Right:
Market size preference for fruit by cultivar in 2021

Cultivar	Preferred average size
Green	32.5
Organic Green	34.8
SunGold	27.8
Organic SunGold	28.1
Red	38.2

Below:
Sample progress payment to growers based on trays submitted of different sizes

CLASS 1 - APPROVED PROGRESS PAYMENT 15 FEBRUARY 2021	AVERAGE ON NET SUBMIT	16/18/22	25/27	30/33	36	39	42
Zespri Green	$0.37	$0.45	$0.45	$0.45	$0.30	$0.30	$0.20
Zespri Organic Green	$0.60	$0.50	$0.70	$0.75	$0.60	$0.60	$0.45
Zespri Gold3	$0.55	$0.65	$0.60	$0.55	$0.45	$0.40	No supply
Zespri Organic Gold3	$0.66	$0.65	$0.70	$0.65	$0.70	$0.55	No supply

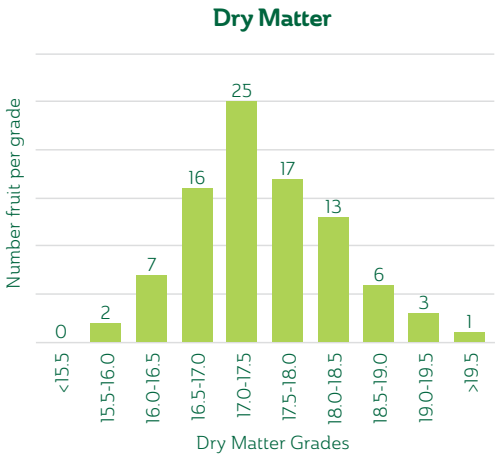
5.2.2 Taste

Taste is primarily driven by the balance of sugars and acids in the fruit. Both are detected by our tongues with sugars providing the 'sweetness' and acids giving the tangy, zesty taste associated with kiwifruit. Volatiles given off by the fruit contribute to the flavour and aroma when they are carried from the mouth onto the sensory receptor in the nose as we chew and swallow food. The volatiles are only present in minute amounts, at parts per million, but have a huge impact on the flavour of kiwifruit.

A significant part of the payment growers receive for their fruit depends on the level of dry matter (DM). This is called the Taste Zespri Programme. This programme was launched in 2001 in an effort to enhance the overall quality of Zespri Kiwifruit, by improving taste consistency. The level of sugar in ripe fruit is determined by the level of starch, or DM in the fruit at harvest. The DM is also a measure of maturity, so Zespri set a minimum level as part of the harvest criteria to ensure fruit will ripen after harvest and reduce the risk of a poor taste experience for consumers. A 90-fruit sample is collected from each orchard before harvest and the percentage dry matter measured (see Chapter 6 for more on this).

Taste Zespri Grade (TZG) was originally based on the premise that Japanese consumers preferred a sweeter tasting kiwifruit and were prepared to pay for it. TZG is a value between 0.0 and 1.0 (or 0.86 for SunGold). TZG is calculated based on a 90-fruit orchard sample for all varieties, and an additional 60 fruit small size targeted sample for Gold3 and Organic Gold3. TZG for Gold3 and Organic Gold3 is calculated and reported by maturity area and fruit size, whereas other varieties are reported on maturity area level only. If multiple samples are completed prior to harvest, the highest TZG calculated from them is used. TZG forms the basis of grower taste payments.

Example: TZG calculation for a conventional green (Hayward) orchard:



- After testing of dry matter, each fruit in the 90-fruit sample is allocated to a dry matter grade (see graph above)
- The number of fruit in a single grade is converted to a percentage of the 90 fruit sample
- Each dry matter grade has a grade value (set by Zespri, differs for each cultivar)
- For each dry matter grade, the %Fruit is multiplied by the grade value.
- Each of these results are then added to give the TZG. In the table below, the values in the first column add to 68% or a TZG of 0.68.

Taste Zespri Grade (TZG) - Green

%Fruit x Grade Value	Fruit Per Grade (% of the 90-fruit sample)	Fruit Per Grade (from graph above)	Grade Value[1]	Dry Matter Grade
0.0	0.0	0	0	<15.5
0.2	2.2	2	0.1	15.5-16.0
1.9	7.8	7	0.25	16.0-16.5
8.0	17.8	16	0.45	16.5-17.0
18.1	27.8	25	0.65	17.0-17.5
16.1	18.9	17	0.85	17.5-18.0
13.0	14.4	13	0.9	18.0-18.5
6.3	6.7	6	0.95	18.5-19.0
3.2	3.3	3	0.97	19.0-19.5
1.1	1.1	1	1	>19.5
		90		Fruit Count
0.68				TZG

Minimum Taste Standard (MTS)

More recent research has demonstrated that consumers liking for fruit decreases significantly if the taste drops below a certain level. This "Minimum Taste Standard" (MTS) has been determined for each variety by Zespri. Fruit that does not meet the MTS, and is therefore not acceptable for export, is either processed or used as stock food.

Example: In 2021, clearance to harvest a green orchard was granted when 70% of the fruit in the 90-fruit sample had DM ≥ 15.5%. The fruit are also allocated into Taste bands when packed to further ensure consistency of taste. There are three taste bands (Y, T, M), Y representing the highest Taste and M representing the lower or more variable Taste. This ensures that Zespri is able to target high taste fruit to Japan and potentially other markets where there is a strong consumer taste preference for sweeter fruit.

Right:
Taste bands and MTS for green (Hayward), 2021

Taste band	Hayward
Y	≥16.6
T	≥16.3<16.6
M	≥MTS<16.3
MTS (Minimum Taste Standard)	15.5% dry matter threshold [1]
Percentage of fruit value to taste	60%
Minimum size for standard supply	42 (≥74g)

[1] 70% of fruit greater than or equal to the threshold.

Zespri also determines a Maximum Taste Payment (MTP) which is reflective of higher value that consumers place on a superior taste experience. The higher the TZG the grower achieves, the greater proportion of the MTP they will receive. The grower's TZG is multiplied by the MTP to calculate their taste payment. In the 2020/21 season the MTP for Hayward was $5.04 per tray whilst Gold3 had a MTP of $9.75 per tray.

As outlined in chapter 3, there are many practices growers can consider throughout the year to increase their dry matter. Including:

- Increasing the temperature of the orchard (by artificial shelter)
- Monitoring crop loads to ensure they are not excessive (thinning)
- Opening up any dark areas of the canopy or areas that may become dark (vine management)
- Summer trunk girdling
- A close root prune on both sides of the vines. This has given, in both scientific and grower trials, a one percent increase in dry matter, on top of a trunk girdle effect
- Monitoring leaf health
- Harvesting later

Right:
Growing superior dry matter in Zespri Kiwifruit *(Zespri, OPC)*

5.2.3 Internal Colour

Internal colour must be fully developed and typical of the cultivar (Gold and Red cultivars only – Red criteria are still being developed). Flesh colour is measured using a chronometer. The clearance criteria requires at least 87/90 fruit to meet the minimum colour standard or colour threshold.

Right:
Fruit sample cultivar in 2020

Cultivar in a 90 fruit sample	Colour Threshold
Gold3 KiwiStart	≤110.7°
Gold3 Advanced Mainpack	≤108.7°
Gold3 Mainpack	≤106.4°

5.2.4 Appearance

Consumers buy with their eyes so appearance is very important. Zespri sets high standards that must be met for fruit to be sold. Fruit that is regular in shape and free from blemish, stain, physical damage, pitting or dehydration will stand out. Consumers keep coming back for more quality Zespri Kiwifruit because they have to meet such high standards.

The following is an example of a Zespri standard:

Cosmetic blemishes such as marks or scars on the skin of the fruit may be caused by:

- Skin rub
- Healed physical damage
- Healed hail damage
- Healed insect damage/cosmetic pests
- Fungal damage
- Skin burn
- Chimera mark

There are allowances for some blemishes in the Zespri Grade Standards Manual as follows:

In all classes blemishes which merge with the colour of the skin are acceptable.

CLASS I - Acceptable blemishes are:

- Superficial
- Light in colour provided they do not affect the general appearance of the fruit.
- Total one square centimetre or less in area.

CLASS Family Kiwi™ - Acceptable blemishes are:

- Blemishes which contrast with the colour of the skin and total two cm squared or less in area are acceptable.

Unacceptable in all classes are:

- Black marks
- Significantly deep or raised blemishes.
- Cosmetic pests which are less than one mm in diameter but total one cm squared or greater in area.

> "Consumers buy with their eyes so appearance is very important. Zespri sets high standards that must be met for fruit to be sold."

5.2.5 Traceability

Our customers expect Zespri to be able to track the journey of kiwifruit from an orchard to the consumer. This includes what sprays have been applied, when fruit was picked, where and when it was packed, where it has been stored, when it is shipped and where it is stored in market. MPI also expect that fruit in each export consignment can be tracked back to a phytosanitary inspection record during packing. Traceability is maintained at both a consolidated level of a pallet and at the individual pack level and tracked through the supply chain by the use of a European Article Number (EAN) barcode. Each pack has an EAN barcode applied which, when scanned, links to a system where details of the fruits journey can be viewed. This allows Zespri to determine market suitability of any piece of fruit. This is used to prevent fruit being shipped to markets where it doesn't meet their access requirements e.g. a pest has been identified on an orchard so its fruit is banned from a certain country. Electronic capture also allows for rapid response, location and segregation should it be required at any point. This is particularly critical should a food safety issue ever arise where accurate tracking is vital to minimise the volume of fruit that may need to be recalled and disposed of. Customer food safety programmes all require high levels of traceability: it is fundamental market requirement.

5.2.6 Chemical Residues

Growers need to use agrichemicals to manage pest and disease levels in their crops. However, markets and individual customers set very specific requirements for the level of agrichemical residues they will accept in fruit. The Zespri Crop Protection Standard (CPS) is actively managed to ensure only approved sprays are used and to minimise the presence of any residues. All lines of fruit are residue tested to ensure adherence to the crop protection standard and ensure that individual market access requirements are met. Most Zespri fruit has no detectable residues present at harvest.

> "Markets and individual customers set very specific requirements for the level of agrichemical residues they will accept in fruit."

5.3 ZESPRI'S ROLE IN THE INDUSTRY – PRACTICES

5.3.1 Consistency of Supply

Customers require a regular supply of consistent product to be able to provide consumers with a reliable source of high quality and high taste kiwifruit 12 months of the year. Capturing and keeping shelf space full is key to the customer relationship and maximises the value to all parties while reducing the New Zealand grower's risk of a competitor's fruit replacing Zespri fruit on the retail shelf. Market planning and shipping programmes all attempt to keep supply available for as long as possible. During the early part of the season when supply is limited, markets are only started when there is sufficient fruit to allow for continued supply.

Having a product with a long, reliable storage life greatly assists being able to provide consumers with a good eating experience over a long selling season. Sales to customers may continue 6-7 months from harvest and final retail sales can extend for another month after that. For both New Zealand growers and for in-market customers having practically all the volume consolidated through one seller in Zespri provides a mechanism to give a high level of assurance of consistent supply.

Zespri uses fruit sourced in the Northern Hemisphere to supply customers when New Zealand fruit is no longer available.

5.3.2 In-Market Distribution

Zespri sell into more than 50 different countries worldwide and work with distribution customers and partners, who buy fruit from Zespri and get the product into wholesale markets and onto the supermarket shelves. From the wharf, the fruit goes into dedicated coolstore distribution centres and on to thousands of wholesale and retail outlets. Zespri serve distribution and retail customers with the optimal balance of Green, Gold and Organic products.

Zespri is dedicated to its customers and is focused on consistently providing excellent product and excellent service. The Zespri System, the integrated production and distribution system used to deliver the world's best kiwifruit to consumers worldwide, is one of the foundation blocks of the Zespri brand. It is the culmination of many years of scientific, technical and practical developments and an uncompromised commitment to continual improvement.

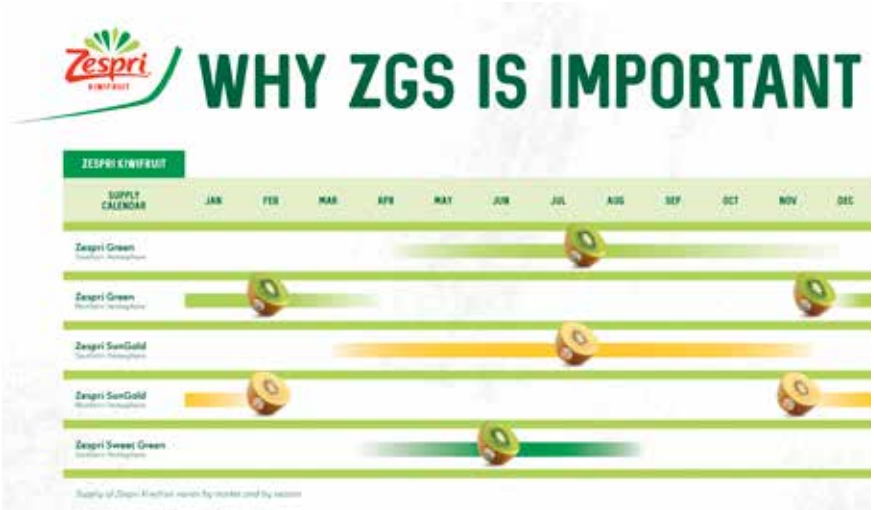
The Zespri System recognises that quality has many components, but they all rely on a combination of best practice, excellent product and documented assurance to provide customer confidence. It has been developed in recognition of customers' needs for a comprehensive assurance that fruit has been grown and handled safely with:

- A strong focus on good agricultural practice.
- Environmental and economic sustainability including the efficient use of natural resources.
- Integrated pest management.
- Orchard to retail traceability.
- A socially responsible approach to workers and the communities it supports, practices that maximise fruit quality, taste and storage potential of the fruit.
- Leading edge good manufacturing practice throughout the postharvest and distribution sectors of the industry.
- An understanding of current and future market and customer needs.
- World class quality management systems.
- Certified food safety and Good Agricultural Practice (GAP) systems.
- Quality specification and measurement throughout the supply chain.
- Comprehensive feedback systems to ensure that customer feedback drives continual improvement.

Watch: https://www.youtube.com/watch?v=UtIwp6DsfXg The Zespri System

Visit: https://www.freshfacts.co.nz/files/freshfacts-2020.pdf for the latest horticulture industry statistics

https://www.zespri.com/content/dam/zespri/nz/annual-reports/Annual_Report_2020_21.pdf. Zespri 2020/21 Annual Report



5.3.3 Integrated Supply System

The development of Zespri's supply chain and service offering is a key focus. Supply chain efficiency is expected to unlock significant value for the industry in future years; many opportunities exist in the supply chain design space with the application of new supply chain management processes and technologies for improving product quality attributes.

The Zespri System is an Integrated System Underpinned by Continuous Improvement

Above:
The Zespri System

Zespri Global Supply (ZGS) business is a source of Zespri's competitive advantage and a key part of Zespri's "category management" work stream. Non-New Zealand supply is poised for strong growth in the five year planning horizon, driven predominately by Gold3 development in Italy, and ability to procure Zespri Green from Italy to meet rising global demand.

The strategic focus of ZGS is to consolidate non-New Zealand supply as a fundamental pillar of Zespri's competitive strength, underpinning its position as a leader in the global fruit industry. Zespri's aim is to unlock value in the business by leveraging the brand, intellectual property and supply chain expertise.

12 Month Supply

12 month supply refers to the procurement and marketing of Northern Hemisphere kiwifruit (when New Zealand fruit is not available in market) to complement the sale of New Zealand kiwifruit. 12 month supply is an important part of Zespri's business strategy and a key source of Zespri's competitive advantage. Specifically it strengthens Zespri's New Zealand kiwifruit business by continually building the brand and strengthening global relationships.

Zespri has partnered with Northern Hemisphere growers in Italy, France, Japan and South Korea for nearly two decades to provide its customers with premium Zespri Kiwifruit in the three-to-four months a year where New Zealand kiwifruit is not available.

The Benefits of Zespri Offering 12 Month Supply in a Market are:

1. To partner with our distributors in kiwifruit 12 months of the year and demonstrate consistent quality and standards, irrespective of origin, to support their strategic objectives and add value to their businesses.
2. To maintain shelf space 12 months of the year – ideally to be the kiwifruit category manager, by offering confirmed volumes and quality for the full year, as opposed to seasonal competitors from other countries who cannot provide such reliability. This allows more flexibility for volumes of New Zealand kiwifruit to be placed in the best position to maximise returns.
3. To maintain brand presence 12 months of the year such that when New Zealand kiwifruit comes into markets, it is not fighting for shelf space with earlier seasonal produce or seeking to displace other produce that is available 12 months of the year.
4. To grow branded products over 12 months rather than just in the New Zealand supply window. This is critical from a category growth perspective, i.e. apples, tomatoes, and bananas are all available 12 months of the year.
5. In growing regions, having a local presence enables Zespri to better manage the pressures placed on distributors and retailers to support local product, by supporting the domestic kiwifruit community, which in most cases are not competitive to Zespri's New Zealand supply windows; further this enables Zespri to maintain the quality standards for the category as a whole in that market.

In Addition, There are Other Benefits to the New Zealand Grower as well Outside of the Market Benefits, such as:

1. Growing in both the Southern and Northern Hemisphere locations allows the New Zealand industry to learn and innovate at twice the pace. This benefit was very evident during the height of Psa where time was against the industry and the learning's needed to be adopted as quickly as possible.
2. ZGS is a "stand alone" business unit that is allocated a portion of overhead costs from other business units, thus allowing for better utilisation of corporate overhead spend.
3. By having activity across 12 months of the year creates a platform to retain core staff; seasonal roles can create staff turnover and an associated loss of experience within the organisation.
4. Developing strong relationships with kiwifruit growers in a range of other countries.

As other kiwifruit brands begin to build momentum and aim for 12 month supply, Zespri needs to maintain a continuous supply strategy and build brand awareness or risk losing future market share to emerging brands. With the plethora of new cultivars grown globally by competitors, it is imperative Zespri retains a strong presence in the market place 12 months of the year to position New Zealand kiwifruit strongly and retain strong customer and distribution relationships. Zespri 12 month supply enhances consumer loyalty and strengthens the position of key distribution partners, when increasingly competitive alternatives are emerging. Therefore, as Zespri Northern Hemisphere supply volumes grow the benefit to New Zealand growers is also increasing.

5.3.4 Variety Licences

Zespri owns the plant variety rights (PVR) for SunGold Kiwifruit, as well as RubyRed. This means growers must purchase a license to be able to grow Zespri's proprietary varieties and are bound by a Zespri Kiwifruit Variety Licence which gives growers the right to acquire plant material for growing a variety within the licensed area.

Since 2018, Zespri has licenced around 750 hectares of SunGold in New Zealand each year (including 50ha of Organic SunGold License). Growers bid for license in a Closed Tender Bid process, and the prices accepted have risen year on year. In 2021, Zespri's revenue from the sale of PVR licenses was $306 million, up from $214 million in 2020. Zespri review the license release annually before making announcement for the following year, so forecasts are subject to change.

The quantity of SunGold Kiwifruit licence to be released in 2022 has been reduced from 700 hectares to 350 hectares. 350 hectares of Zespri RubyRed Kiwifruit licence will also be released, with that number expected to grow to 500 hectares in 2023, subject to next year's annual review of licence release. Additionally, there will be no release of Zespri Organic SunGold Kiwifruit licence in 2022. This is due to both higher than expected yields on organic orchards and more organic conversions meaning we expect to reach target supply volumes of 6.2 million trays by 2026.

Zespri Chairman Bruce Cameron says the plan for the 2022 licence release reflects Zespri's focus on ensuring they can provide strong and sustainable returns to growers by ensuring demand continues to exceed supply.

"We remain incredibly confident in the market demand outlook, with global demand for our fruit continuing to strengthen, along with the value we are able to capture for growers, if we maintain our approach of building market demand ahead of supply," Bruce Cameron.

Supply volumes are increasing, with growers achieving strong yields per hectare, and with a continued focus on delivering fruit of high quality to our markets. Concurrently, the industry is confronted by a range of challenges, primarily driven by COVID-19 which continues to have an impact across our value and supply chain.

"An interim slowdown in licence release allows us to address this while ensuring we have some time to watch the rapidly evolving COVID-19 situation unfold, including the reopening of New Zealand to the world and changes to immigration settings," says Bruce. As a result of the reduction of Zespri SunGold Kiwifruit licence to 350 hectares, adjustments have also been made to the Zespri SunGold Kiwifruit Closed Tender Bid process to apply a number of restrictions to help spread the reduced licence amongst growers.

5.4 ORCHARD ACCOUNTING 101

Monitoring of Kiwifruit Orchard Profitability

The monitoring of profitability is an important review of the financial performance of an orchard.

There are numerous orcharding activities that give rise to both income and costs on an orchard and growers give much time and thought into delivering the successful production of their crops.

Monitoring and review of the financial performance of an orchard should be viewed as the financial result of that time. It is this result that demonstrates financial success and the meeting of grower expectation or not.

Please see diagram 1 (Hayward) & diagram 2 (SunGold) for an example of a simple orchard profit and cash-flow report.

There are four key areas that will be covered:

1. Seasonal Timing of Orchard Income and Costs
2. The Concept of Orchard Gate Return
3. Orchard Financial Reporting
4. Collection of Financial Data

Seasonal Timing of Orchard Income and Costs

The orcharding cash cycle of setting up an orchard in preparation for harvest and receiving the final income for that same harvest is spread over twenty-four months.

The kiwifruit orcharding year begins with winter pruning around July and continues through to harvest. Harvest is typically conducted during the months of April and May. Throughout this growing period numerous orcharding costs are incurred as the new crop is setup and tendered (such as pruning, pollination, fertiliser etc.).

Following harvest and the successful submit of fruit into Zespri inventory; net income is returned to the grower. Final net income is not received by the grower until June of the year following harvest.

The Concept of Orchard Gate Return

Net Income received by a grower is referred to as *Orchard Gate Return* or OGR.

In simple terms, Zespri receive money (gross income) from export customers. This is then distributed through to Registered Suppliers, and onto growers. The reason Orchard Gate Return is referred to as a Net Income is because the gross income received by Zespri is offset by various costs and incentives including postharvest costs such as packaging and logistics.

These costs and incentives are outlined in the contractual arrangement a grower has with their post-harvest partner and in the Supply Agreement signed by Registered Suppliers and Zespri.

A grower's preferred format for illustrating Orchard Gate Return for a full year is as follows:

	2020 Harvest ($ are for example only)	2020 Harvest ($ are for example only)
Income from Zespri		
Zespri Fruit Return	55,075	111,296
Plus Taste Income	38,028	88,945
Plus Early Start Income	5,841	13,778
Plus Loyalty Income	3,576	4,593
Total Income from Zespri	**102,521**	**218,613**
Cost of Postharvest		
Time Incentive Income	15,855	22,964
Less Fruit Loss Costs	-1,907	-4,899
Less Time Costs	-6,080	-6,736
Plus/Less Intercheck	954	919
Net Time Incentive	**8,822**	**12,247**
Less Packing & Harvest Costs	-24,676	-48,376
Less Coolstore Costs	-11,325	-14,544
Less Logistics Costs	-1,669	-2,296
Less Other	2,027	1,684
Total Cost of Postharvest	**-35,644**	**-63,532**
Total Net Income (Orchard Gate Return)	**75,698**	**167,327**

Above:
Table showing Orchard Gate Return for a full year

It is noteworthy to mention that Orchard Gate Return is not the complete measurement of orchard performance as it does not take into consideration orcharding costs such as pruning, pollination, fertiliser etc. Therefore, Orchard Gate Return is not the final formulation of orchard profitability.

Orchard Financial Reporting

The preparation of a financial report of the performance of an orchard is a tool a grower will use to measure the profitability of an orchard. It also forms part of the analysis in which to measure the financial viability of that orchard along with a grower's financial expectation and objective.

Table 1 (Hayward) & Table 2 (SunGold) provide examples of a simple orchard net profit and cash-flow report. The format works through:

Net Income (OGR)
less Orcharding costs
Net Profit from Orcharding
less Capital expenditure
Net Cash Inflow/Outflow

Net Profit from Orcharding shows the profitability of all income derived from each harvest less all direct costs that are incurred in delivering that same harvest.

Net Cash Inflow/Outflow provides useful analysis of the net cash proceeds received from the orchard by considering capital expenditure such as setting up a new overhead artificial canopy.

It is noted that repairs and maintenance and capital expenditure have been left blank is these tables, as this is a discretionary spend that will vary between orchards. Nevertheless, there would be some repairs and maintenance each year that would need to be budgeted for along with any capital expenditure required.

Typically, such a report would be reviewed on a monthly basis and annually.

These tables include columns for each month that Net Income (OGR) is received. This example is based on 1 canopy hectare. Generally, an orchard would not be exactly one canopy hectare so an additional column would be included to show the income or cost into a Per Canopy Hectare basis.

This Per Canopy Hectare calculation is the most common and important metric used by a grower to benchmark the financial performance of their orchard against industry averages and prior historical information.

As the orcharding year progresses a grower will find it necessary to understand the costs they incur on a 'per hectare basis'. Often piecemeal rates charged by suppliers and contractors are also based on a 'per hectare basis', such as winter pruning and girdling.

Collection of Financial Data

Collating this data into a user-friendly format such as in Table 1 & 2, must be simple and readily available.

There are a variety of means available to a grower to prepare such a report and often it is prepared with support from the grower's Chartered Accountant.

Financial reporting has come a long way in recent years and apart from simple spreadsheets, there are a number of web-based financial software tools available to growers to draw financial information from, such as Xero.

KIWIBOP ORCHARD

KIWIFRUIT ORCHARD PROFITABILITY

KPIN:
LOCATION:
HARVEST YEAR: 2020
VARIETY: HAYWARD Conventional

[NUMBERS ARE FOR EXAMPLE ONLY]

Key inputs		
CAN/HA	F/VINES	M/VINES
1.00		

Trays: 11,921

Diagram 1

	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Total Per CAN/HA
Net Income																
Net fruit payments (Orchard Gate Return)		3,785	757	6,056	5,299	3,785	10,598	12,869	15,897	2,271	3,028	6,813	757		3,785	75,698
ORCHARD COSTS																
Harvesting costs			7,749													7,749
Orchard Production																
Winter pruning				7,300												9,300
Male pruning									3,000							3,000
Summer pruning								1,000		1,750	2,750					5,500
Thinning										470		4,230				4,700
Girdling									250		250					500
Spraying (materials & application)			650		350	1,000		500		1,000	250	1,250				5,000
Fertiliser (materials & application)					1,000			1,000								2,000
Weed control (materials & application)								400		400						800
Pest monitoring										250						250
Soil tests/leaf samples			625					625								1,250
Pollination								3,500								3,500
Mowing & Mulching	150			150			150			150						600
Shelter trimming					500											500
Global gap/compliance										450						450
Repairs & maintenance																-
Management	750			750			750			750						3,000
Total orchard production	900	-	1,275	8,200	1,850	1,000	900	7,025	3,250	5,220	3,250	5,480	-	-	-	40,350
Net Profit from Orcharding	-900	3,785	-8,267	-2,144	3,449	2,785	9,698	5,844	12,647	-2,949	-222	1,333	757	0	3,785	27,599
Capital expenditure																-
NET CASH INFLOW/(OUTFLOW)	-$900	$3,785	-$8,267	-$2,144	$3,449	$2,785	$9,698	$5,844	$12,647	-$2,949	-$222	$1,333	$757	$0	$3,785	$29,599
YTD NET CASH INFLOW/(OUTFLOW)	-$900	$2,885	-$5,382	-$7,526	-$4,077	-$1,292	$8,406	$14,249	$26,896	$23,947	$23,725	$25,057	$25,814	$25,814	$29,599	$29,599

KIWIBOP ORCHARD

KIWIFRUIT ORCHARD PROFITABILITY

KPIN:
LOCATION:
HARVEST YEAR: 2020
VARIETY: SunGold Conventional

[NUMBERS ARE FOR EXAMPLE ONLY]

Key inputs		
CAN/HA	F/VINES	M/VINES
1.00		

Trays: 15,309

Diagram 2

	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Total Per CAN/HA
Net Income																
Net fruit payments (Orchard Gate Return)		10,040		15,059	31,792	28,446	21,753	23,426	15,059	1,673	8,366	8,366	1,673		1,673	167,327
ORCHARD COSTS																
Harvesting costs			9,951													9,951
Orchard Production																
Winter pruning				10,000												10,000
Male pruning								2,500								3,000
Summer pruning								2,000		3,500	3,500					9,000
Thinning							2,325		7,750		5,425					15,500
Girdling									375		375					750
Spraying (materials & application)			780		420	1,200		600		1,200	300	1,500				6,000
Fertiliser (materials & application)					1,800			1,800								3,600
Weed control (materials & application)								400		400						800
Pest monitoring										250						250
Soil tests/leaf samples			625					625								1,250
Pollination								3,500								3,500
Mowing & Mulching	150			150			150			150						600
Shelter trimming					500											500
Global gap/compliance										450						450
Repairs & maintenance																-
Management	750			750			750			750						3,000
Total orchard production	900	-	1,405	10,900	2,720	1,200	3,225	11,425	8,125	6,700	9,600	1,500	-	-	-	58,200
Net Profit from Orcharding	-900	10,040	-11,356	4,159	29,072	27,246	18,528	12,001	6,934	-5,027	-1,234	6,866	1,673	0	1,673	99,176
Capital expenditure																-
NET CASH INFLOW/(OUTFLOW)	-$900	$10,040	-$11,356	$4,159	$29,072	$27,246	$18,528	$12,001	$6,934	-$5,027	-$1,234	$6,866	$1,673	$0	$1,673	$99,676
YTD NET CASH INFLOW/(OUTFLOW)	-$900	$9,140	-$2,216	$1,943	$31,015	$58,261	$76,788	$88,789	$95,724	$90,697	$89,463	$96,330	$98,003	$98,003	$99,676	$99,676

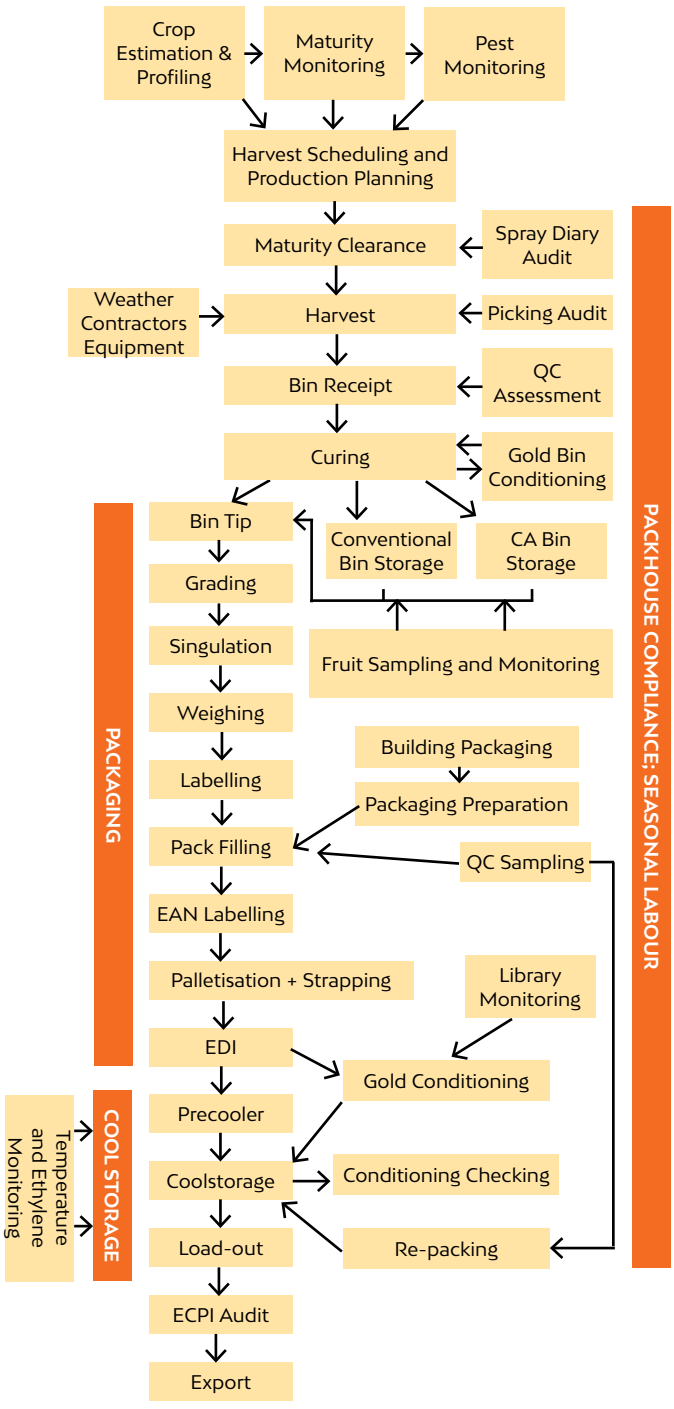
NOTES

CHAPTER SIX

HARVEST AND POSTHARVEST PRACTICES

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER SIX
HARVEST AND POSTHARVEST PRACTICES



The diagram to the left outlines the key processes and management actions that take place in preparation for and after harvest.

This chapter will now go into each of the actions outlined in the flow chart to the left. This chapter will be split into two broad sections including:

THE SECTION IS DIVIDED AS FOLLOWS

6.1 HARVEST

To ensure consumers continue to buy Zespri Kiwifruit, it is important that the fruit taste consistently good. Before fruit is harvested, it must be mature enough to ripen when it is off the kiwifruit vine. Depending on the variety (as the criteria can vary for each), the fruit needs to meet:

- the minimum dry matter (DM) threshold
- the right colour (Gold3 only)
- the minimum Soluble Solid Concentration (SSC) or brix (sugar content of an aqueous solution)
- have sufficient black seeds (Hayward only)
- minimum firmness

When it is time to harvest, an independent laboratory will test the fruit maturity, and if it meets the standard will give a clearance to pick. Dry matter is the most important aspect of fruit maturity for a grower, as a large proportion of their fruit payment is based on the dry matter percentage. Dry matter is largely made up of starch; this starch is converted into fruit sugars during the ripening process. The higher the dry matter, the greater the potential for high soluble solids when the fruit is ready to eat; high levels of soluble solids generally mean tasty fruit.

Additionally, a residue test must be taken to confirm the fruit has been grown to the crop protection standard (CPS). Residue tests involve taking a fruit sample that is sent to the lab for analysis, where approximately 350 compounds are screened for. The test result is only valid for 42 days so if harvest is delayed a second test may be required.

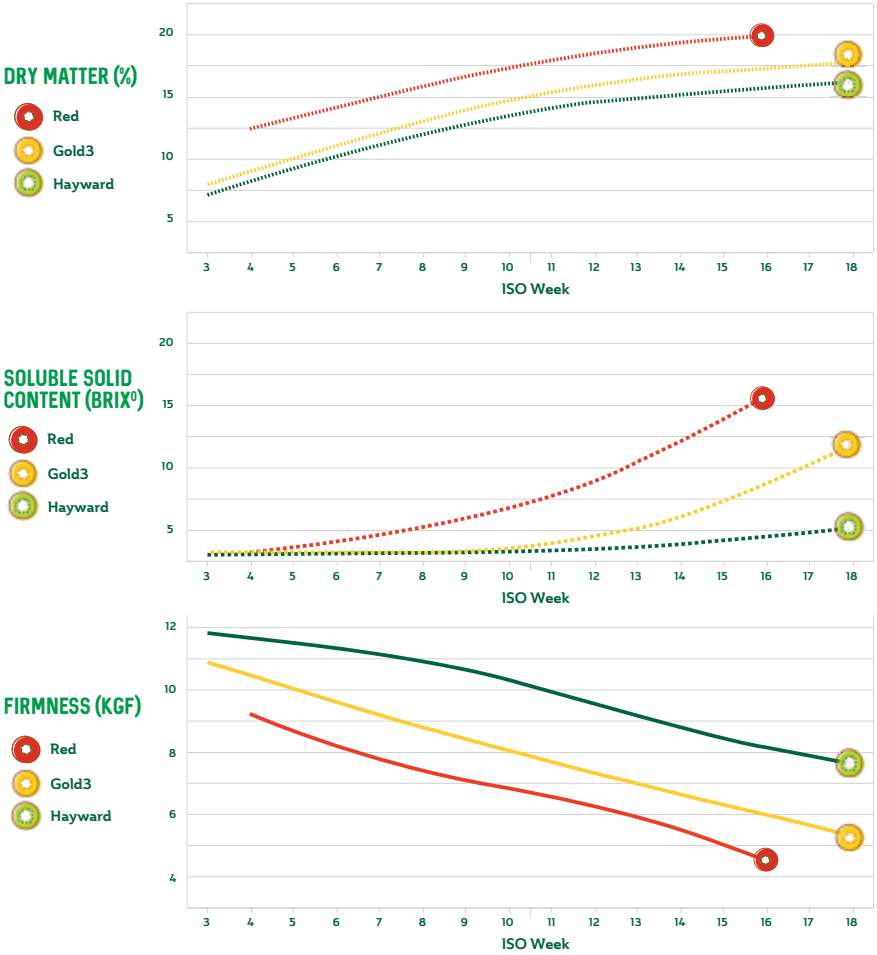
Right:
Sampler collecting a maturity sample

Right:
Fruit slices after being dried in a dehydrator

Testing for Dry Matter

Dry matter is measured by cutting a 2-3mm slice from the middle of the fruit and drying it in a dehydrator – the proportional difference between the wet weight of the slice and the dry weight of the slice is the dry matter percentage. The dry matter percentages from every fruit in the sample is used to calculate the Taste Zespri Grade (TZG) of the sample. The TZG is then used to determine how much of the maximum taste payment a grower will receive, e.g., if the maximum taste payment for a tray of fruit was $5.00, a TZG of 0.8 would mean that the grower would receive 80% of the maximum taste payment, or $4.00 per tray.

Soluble solids concentration (SSC) or brix is measured by a refractometer which uses light refraction to measure different sugar concentrations. Degrees of brix are the units of measure a refractometer uses. SSC and brix are effectively interchangeable terms. Generally, the greater the maturity at harvest the greater the taste and storage potential of the fruit. Brix can also be used when the fruit is eating ripe as a measure of how 'sweet' the fruit is. Fruit is increasingly being tested by retailers at the point of sale as an assessment of fruit quality. The higher the dry matter of fruit at harvest the higher the brix will be when sold at eating firmness at point of sale.



Note: The curves represent averages from multiple seasons and sites.

Note: ISO Week refers to the International Organization for Standardization date and time standard. Using this standard across the value chain reduces confusion between countries who may measure the start and end of a week differently (ISO week is Mon-Sun).

6.1.1 Timing

Each variety reaches maturity at a different time, depending on location and seasonal climate fluctuations. Gold kiwifruit harvest starts in mid to late March and is normally complete by early May. Poverty Bay, Hawke's Bay and coastal Bay of Plenty are usually harvested ahead of other regions. Research is still ongoing for Red kiwifruit, but it is expected to be mature around early March. Hayward (Green) harvest starts in late March and peaks in May and is usually complete by early June. There are some regional variations with Poverty Bay and coastal Bay of Plenty having the earliest harvest most years. Harvest in the more elevated regions in the Bay of Plenty follow in May and June. Nelson has a relatively short harvest window due to their naturally later maturity and early onset of winter cold. This means harvest is usually limited to the first three weeks of May.

6.1.2 Kiwistart Premium

The fruit picked at the start of the season is termed 'KiwiStart'. This fruit has reached a level of maturity where it will ripen off the vine and be acceptable to consumers but has not reached its optimum size or taste on the vine. Zespri incentivise growers to pick early by compensating them for lost fruit size and taste payments. Zespri want fruit to hit the markets shelves before competitor fruit from Chile. Further, Zespri want to sell as much fruit as possible before mainpack in May. A more balanced supply over time also reduces storage costs and fruit loss.

6.1.3 Time Payments

KiwiStart compensates growers for their fruit being sold early; Time Payments compensate growers for their fruit being sold late. Time Payments cover the additional costs of storing and supplying kiwifruit overtime. As kiwifruit is stored longer, it requires additional coolstorage and because the fruit is deteriorating overtime, condition checking, repacking, fruit loss, and taste compensation levels all increase. There are a variety of variables that lead to kiwifruit being able to be stored for months. Maximising storage potential requires optimisation of inventory management practice, fruit maturity and high-quality fruit handling.

KiwiStart and Time Premiums extend the New Zealand kiwifruit selling season. Markets require consistent supply so that New Zealand kiwifruit is available to their customers for as long as possible.

Right:
Emptying fruit into bins for transport to the packhouse

6.2 POSTHARVEST

Packing and cool storage are not regulated by statute and there is active competition between postharvest operators that helps to minimise growers' postharvest costs. There are approximately 53 packing facilities and 85+ coolstores used in the kiwifruit industry. These facilities are located in Northland, Auckland, Bay of Plenty, Gisborne, Nelson and the Manawatu. The smallest facilities pack from 200,000 trays (3.55kg/tray) per season whilst the largest pack upwards of 15 million trays per season.

A packhouse operator receives fruit from the kiwifruit orchard in bins. These bins are not always packed immediately but left to sit for the fruit to cure. Curing refers to the delay between harvest and fruit entering the cool store. This is optimally for 48hrs, in a covered but well-ventilated area at ambient temperature. This removes the field heat from the fruit and allows for some drying out of the stem scar and other physiological changes in the fruit that can lead to better long term storage performance and less risk of botrytis rot. The fruit then passes through the packing chain to be packed and stored before shipping or is stored for a time in controlled-atmosphere (CA) storage before packing.

Right:
Kiwifruit passing over grading tables in the packhouse.

Far right:
Kiwifruit on the sizer where they are weighted and sent to the packing lane where that size is being packed

6.2.1 Packing

Packing is the key control point where the fruit is segregated into market acceptable product. Fruit is graded for defects, sized, labelled, and placed into packs suitable for the market (either trays or loose-filled bulk packs). Quality Control (QC) staff take samples of fruit to monitor for pest or defects that may have been missed and to ensure all parts of the packing and coolstore process meet the relevant standards. Product traceability moves from the orchard bin down to the individual pack level. It is at this point that maturity, dry matter, Global Good Agricultural Practice (GAP) requirements and market restrictions and regulations are all consolidated and identified electronically at the pack and pallet level, using EAN (European Article Number) barcode labels. For more information on GAP, see Chapter 8. For more information about the equipment used in the pack house see Chapter 7.

6.2.2 Labelling

Markets have wide ranging pack and label requirements. Individual fruit labelling of the Zespri brand is a requirement in all markets in preparation for retail sale. All fruit labels contain either a Price Look-Up (PLU) code for that cultivar and size of kiwifruit, or a bar code for price point differentiation by size at the point of sale. Some markets have additional market specific labelling requirements at the individual pack level. For example, South Korea, Brazil, India, Malaysia, Vietnam and Russia, all require country specific language showing the local contact details of the importer. These labels must exactly meet the importing countries statutory requirements to allow entry.

Right:
Individual fruit label with bar code.

6.2.3 Packaging

Packaging is a key market messaging tool with branding and graphics carefully controlled. In some cases, customers require specific packaging requirements. In-market packing is used to meet customer requirements with fruit transferred from loose filled bulk packs into smaller retail packs or bags. All packaging must protect the fruit through the whole supply chain and be able to be disposed of at the end of its use in market. There are a variety of pack types that customers can order.

Right:
Examples of Zespri kiwifruit repackaged into retail packs for specific markets

6.2.4 Coolstorage

Coolstores, utilising refrigerated air, are used to reduce the temperature of kiwifruit so that it stores for longer. Controlled atmosphere (CA) storage is also used where oxygen, and carbon dioxide concentrations, as well as temperature and humidity, are regulated to enable kiwifruit to store longer. EDI (Electronic Data Interface) is the system by which data is fed from the packhouse to Zespri for the overall inventory management. This data includes information about the fruit packed and stored so that each tray can be assigned to the appropriate market for load out. Further quality checks are completed at the wharf before the fruit is loaded via a ECPI audit (Export Consignment Product Inspections).

6.2.5 Shipping

Zespri uses two modes of shipping to deliver kiwifruit from New Zealand to offshore global markets: chartered refrigerated ships (or reefer ships) and containerised liner services. The 2021 season was marked by significant issues related to the Global Supply Chain Crisis (due to disruption by the pandemic) resulting in Zespri sending over 54% of volumes to markets on reefer ships. On average the historical split sits around 40 % Reefer vessels: 60 % Containerised Liner Services.

Reefer Ships

Zespri "hires" or charters a whole ship, controls where and when the ship will travel and only carries the one cargo type, kiwifruit. These ships carry between 2,500-6,000 pallets. Reefer ships load kiwifruit at various regional ports in New Zealand, close to where fruit is harvested (Nelson, Gisborne and Marsden Point) however most of the volume is loaded out from the port at Tauranga. Once fully loaded, the charter vessels travel direct to the key markets of Europe, Japan, China and Korea, a journey of between 2-4 weeks. Reefer ships offer the advantages of quick direct transit times, ability to condition fruit whilst transiting to a destination and allow large volumes of fruit to be delivered to markets.

A Zespri Fruit Monitoring Technician (FMT) travels on-board each reefer, from mid-March to mid-June, to carry out the fruit conditioning. This involves ripening the fruit so it is in a 'Ready to Retail' state when it gets to market, with the characteristic textures and flavours. Their role involves assessing fruit development, monitoring fruit flesh and air temperatures, and releasing ethylene gas on request. The fruit development and temperature data they collect on board is sent back to Zespri for assessment, then any required actions are communicated back.

Right:
A typical reefer ship

Right:
Pallets being lowered and stowed into the hold of a reefer ship

Containerised Liner Services

Container ships are capable of carrying a variety of cargo types belonging to different cargo owners. Cargo is loaded and stowed on the vessel in units called TEU (twenty-foot equivalent unit) or FEU (forty-foot equivalent unit) that can be either dry or refrigerated units. Zespri uses refrigerated FEU units that carry 20 pallets of kiwifruit per FEU. These ships travel a fixed route every week, which may involve stops at many ports prior to reaching the final destination, similar to the experience of taking a ride on a public bus. Zespri uses such services to many destinations including Taiwan, USA, Australia, South-East Asia, Middle East, South America, and South Africa.

Containerised services offer the benefits of a cost-effective freight solution as only the required space is booked and there is the ability to send cargo to many destinations.

In 2021, it is estimated Zespri will ship globally from New Zealand over 14,500 FEU (290,000 pallets) on containerised liner services and charter some 66 reefer ships carrying over 379,000 pallets.

Right:
A typical container ship

CHAPTER SEVEN

TECHNOLOGY

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

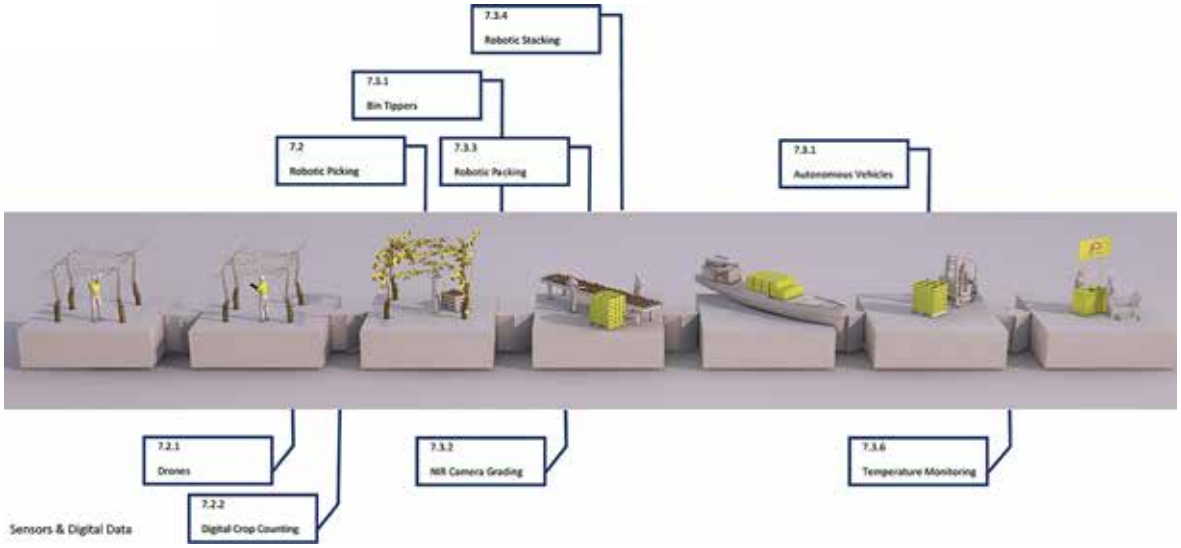
CHAPTER SEVEN
TECHNOLOGY

Technology is an incredibly exciting space in horticulture where the industry is working on a number of ideas to improve productivity, address labour constraints and increase output. This chapter will examine the key areas of the supply chain to understand where technology currently is and where it may take us in the future.

THE SECTION IS DIVIDED AS FOLLOWS

7.1 TECHNOLOGY

While technology has always been an important part of the horticulture industry, it is becoming increasingly so. Technology can come in several forms: Robotics and automation are usually introduced to drive efficiencies in tasks typically requiring human labour that are either dangerous, dull or dirty. A second form of technology is the increasing use of sensors to measure, monitor or analyse areas of the kiwifruit supply chain where more information, or more accurate information is required. There are several drivers to where technology will take the industry over the coming years, however the key immediate driver is the concern around labour scarcity. New Zealand currently has extremely low unemployment and if continued, will impact upon the ability to help with industry growth aspirations. The kiwifruit industry will require an additional 9,000 seasonal workers by 2031 in order to harvest and pack the predicted crop volumes based on the current operating systems in place. Ongoing adoption of technology within the industry, while addressing the immediate concerns around labour shortages, will also enable (and require) an entirely new job market. This market will be one of highly skilled/upskilled labour to build, service and maintain automation technologies, and equally skilled individuals to analyse, interpret and act on the sensor data to improve the efficiency of the kiwifruit supply chain.



Above:
A snapshot of the kiwifruit supply chain from production to consumer highlighting areas discussed further in this chapter 7

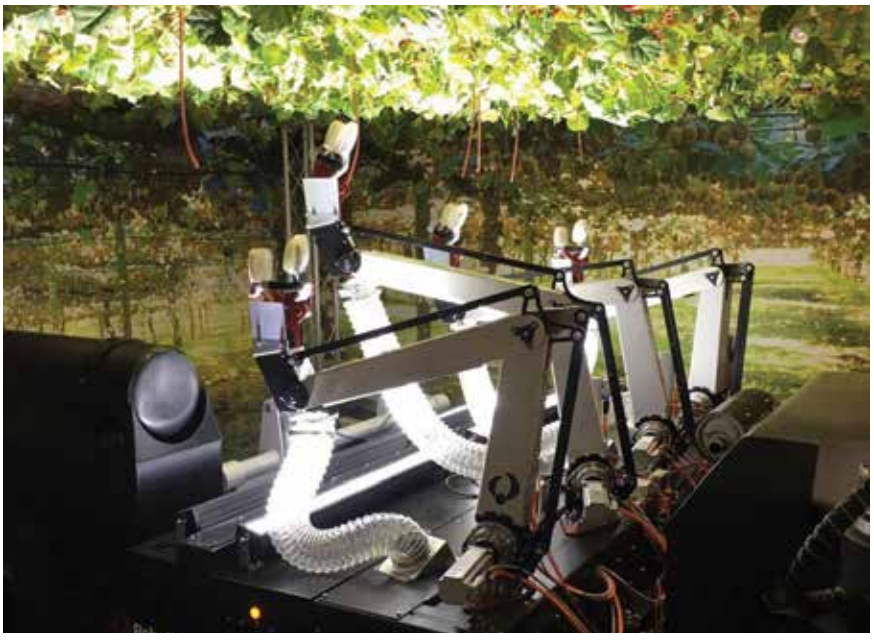
7.2 ON THE ORCHARD

Kiwifruit crops require a high labour input to maintain and grow successfully. Key activities include vine maintenance and harvest. Pruning is vital to ensuring a balance between vegetative growth and fruit production. Harvesting is a labour-intensive task that is particularly time critical.

Finding automated answers to these issues is both complex and expensive. Other crops in New Zealand have benefited from the development of technology in much larger growing areas with better access to capital investment overseas (e.g., apples, grapes). However, kiwifruit production worldwide is comparatively small and New Zealand is the world leader. The number of New Zealand based orchard operators of large enough scale to have access to the necessary capital for technology development is also very small.

While mechanical pruning has been developed in other crops, it always comes at a cost of quality. Similarly, robotic harvesting comes in many different forms but there are some unique aspects to growing kiwifruit that make it particularly challenging e.g., fruit that are susceptible to damage. Finding technological answers to allow the production of high volumes of quality fruit, and picking those crops in the appropriate window, with less reliance on seasonal labour, will be on ongoing challenge for the industry.

Right:
Robotics Plus prototype kiwifruit pollinating autonomous vehicle



Right:
Robotics Plus kiwifruit harvesting autonomous vehicle

7.2.1 Drones, GPS Units and GIS Software

There have been advancements in other areas contributing to crop production on the orchard. UAV (Unmanned Aerial Vehicles or Drones) can be used to monitor crop conditions, the impact of droughts or floods, and to assess requirements for fertilisation and irrigation. By compiling and digitally analysing records from multiple flights and multiple areas of the orchard over time, UAV technology can help the kiwifruit industry to gain new insights regarding climate change, water resource management and rates of soil erosion.

Under New Zealand's laws, commercial UAVs can be utilised as long as they operate in line of sight of the person controlling them and are flown beneath 120 metres. However, the technology is capable of much more than that: UAVs can be flown from anywhere or preprogramed to follow a flight path and undertake functions using GPS.

Zespri contracts GPS-it, a farm and orchard mapping company who utilise UAV technology for orchard mapping and audits of orchards growing licensed varieties. All orchards are subject to audit by Zespri when they have grafted or planted their new license allocation, and subsequent random audits are also carried out from time to time.

The three main technologies used are:

- High accuracy GPS units
- Drones (UAV) used to capture aerial imagery
- Geographic Information Systems (GIS) software to process and present the maps.

All three technologies have undergone significant advancement over the past 20 years. The accuracy and reliability of GPS units has improved along with an increased number of available satellites; UAV's have become more commercially popular; and GIS software has become much more accessible and user-friendly. Together they complement each other to produce high accuracy results that are essential for the audit programme, considering the high value of Gold3 orchards and licences. The data produced from this process can be used by Zespri and growers to assist with many important decisions such as PVR enforcement, crop estimation, biosecurity readiness, pest and disease management and more. Growers can also access this data and utilise it to generate precise plans that will help them make important decisions with confidence.

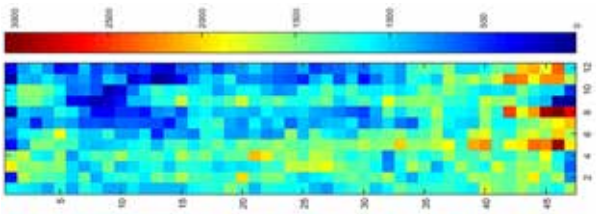
For more information see **www.gpsit.co.nz**

> "UAV technology can help the kiwifruit industry to gain new insights regarding climate change, water resource management and rates of soil erosion."

7.2.2 Digital Crop Counting Technology

Accurate crop estimates (of volume and size profile) are important for the grower to make crop management decisions; for postharvest for operational planning; and for Zespri to make decisions around logistics and market planning. Until recently crop estimation has involved a combination of historical crop data and manual monitoring – taking fruit samples from different areas of the orchard and physically measuring and recording size and weight data. Sampling can be expensive, time consuming, and of limited accuracy due to natural variation across orchards. With the advent of ground-based camera imaging systems, this information can be obtained faster, earlier and more accurately. These systems need to be ground based to count what is most important to the industry – flower buds, flowers and fruit. These parts of the kiwifruit vine are hidden by leaves when viewed from above e.g., from a drone. Camera units travel beneath the canopy and record a video of the canopy from below. New software technology analyses the video in real time, for example: identifying individual fruit, estimating the dimensions (length, width, height) of each, taking the distance from the camera into account and using triangulation for accuracy, then utilising an algorithm determined from machine learning/AI modelling to estimate the weight of each fruit from its dimensions. Using this technology one hectare of orchard can be scanned per hour.

For more information see **www.planttechreserach.com.**



Right:
A visualisation from part of a Gold3 orchard showing the total fruit counted. Each square is one management area within which orchard management decisions can be made. In this image, over 650,000 individual fruits have been tracked and counted.

7.3 POSTHARVEST

A large amount of labour is required to grade and pack the fruit into export pallets of product ready to ship around the world. Considerable investment has gone into technological advancements in the postharvest space. These have increased efficiencies and the capacity of operators to deal with increasing crop volumes. There has been a reduction in dependence on unskilled labour, with a number or roles redeployed within packhouse facilities, and a corresponding increase in roles for skilled people to help keep the technology running.

7.3.1 Bin Tippers

When the bins of fruit arrive from the orchard at the packhouse, they must be emptied into the grading and packing line. The technology that assists with this activity is an automated bin tipper. These can handle the variety of bin sizes and types (wooden or plastic) used in the industry and allow continuous flow of between 5-100 bins per hour depending on size.

Right:
The Sorma bin tipper continuously empties bins autonomously onto the grading line

7.3.2 Near Infrared and Camera Grading

Once on the grading line, camera grading is increasingly being used. The multiple high-speed cameras capture over 300 high-definition images of each piece of fruit as it travels across the grading line. These images are processed to identify external fruit defects, including blemishes, flat fruit, soft fruit, and sooty mould. Near Infrared (NIR) Technology can be used to assess internal quality of the fruit.

The grading machine then accepts or rejects the fruit and the ones that are accepted are then bumped off the line at the right time to be packed in trays with fruit of the same size and quality. This was all once undertaken by individuals handling every piece of fruit and the use of this technology has reduced the number of manual graders on an average shift from 20 down to 3.

Right:
NIR grading machine

How Does NIR Work?

NIR cameras pulse light into fruit and measure changes in wavelengths in rebounded light. From this, the NIR machine can measure the internal qualities of fruit including dry matter, brix, colour, and pressure.

One purpose of NIR technology is to recover fruit which is above dry matter thresholds, from size counts which have failed to meet dry matter requirements. For example, the Minimum Taste Standard (MTS) for Gold3 in 2021 was 70% of fruit sampled met a Dry Matter (DM) level of ≥16.1%. Small count sizes generally have lower dry matter, and it isn't uncommon for smaller size counts (36's and 39's) to fail MTS. Even though fruit has failed to meet the 70% DM threshold, a percentage of fruit in these size counts will be above 16.1%. Some of this fruit can be recovered as class 1 using NIR technology.

The flesh of gold fruit is green until it matures. Gold must meet colour requirements to achieve harvest clearance i.e., change from green to gold. Fruit is tested using a chronometer. Even when fruit achieves clearance, there will be a percentage which is green, and requires colour conditioning at ambient temperature before it can be accepted into inventory. NIR allows green fruit to be treated separately, making the colour conditioning process more efficient.

Another bonus with NIR technology is that it has the potential to make better decisions on how long the fruit will last e.g., should the fruit be sold quickly, or will it last the distance on a ship to Europe? The technology can optimize storage potential by segregating fruit within 'ideal' ranges. For example, a desirable brix range for long storing Hayward (Green) kiwifruit is 8˚- 11˚ at harvest. Fruit outside of the ideal range can be segregated and shipped early, thereby improving the storage potential of fruit within the ideal range.

For more information see **www.compacsort.com**

7.3.3 Automated Packing

After each piece of fruit is labelled, the fruit is packed by size into bulk packs or layered trays depending on the orders received and the market it is destined for. This is often where a bottleneck occurs in the process if the packing is being done by hand. Various technological solutions are in use, with varying levels of automation, from tray/box prep, addition of plastic liners, through to automatic box and tray fillers.

One of the first automated tray packing machines was The Pacmaster, developed in 2017/18 by Apata Group and MAF NZ, a local subsidiary of MAF RODA Agrobotic (France). As technology has progressed, companies like MAF RODA have applied sensor and robotic componentry to assist with presenting the fruit to the machine in a way where variability is managed. This means that the machine can consistently and accurately pick up the fruit, without dropping them, while also handling each fruit very gently so as to not damage or bruise the product.

Unique components of the Pacmaster include inclined conveyors with smart fruit sensing capability, multi-format heads that adapt to the different tray layout and individual suction cups that can lift the fruit and position them into the tray. The fruit size being packed can change quickly in any pack run, and the Pacmaster is able to quickly alter the number of suction cups used depending on the amount of kiwifruit required in the specific tray. Initial testing on site in the 2019 kiwifruit season showed that the Pacmaster could consistently pack 22 trays of kiwifruit per minute. This is a significant change compared to older tray packing versions at 15 trays per minute or the 3 trays per minute achieved on average by packing staff per outlet on a sizer.

For more information see **www.mafnz.com**

Right:
The Pacmaster

7.3.4 Palletisation

After grading and being placed into their trays or boxes, the fruit then need to be assembled onto pallets and strapped down (palletisation), ready for shipping, before they can be put into cool storage. The technology may or may not include the use of robotic stackers taking the boxes directly off the packing line and placing them on the wooden pallet, stacking to the required height. Separate palletisers complete the corner board positioning and strapping. This removes the need for human input in this task, saving time, producing a more consistent pallet, and removing the risk of injury from heavy lifting.

Right:
Robotic arms placing full boxes of produce onto pallets ready for coolstorage

7.3.5 Autonomous Vehicles

Right:
A Skilled Group autonomous forklift that moves product without human interference

Forklifts require labour for operation, and operators need training to become proficient. Improving EV technology has led to the development of electric forklifts that are quieter, less polluting and remove the risk of carbon monoxide poisoning when used indoors. Completely autonomous vehicles are being deployed in great numbers globally in a large variety of production and warehousing environments including the horticulture sector. Millions of bins and pallets are moved across the same paths and into similar locations constantly in the packhouse environment which can also be undertaken via the automated fleet.

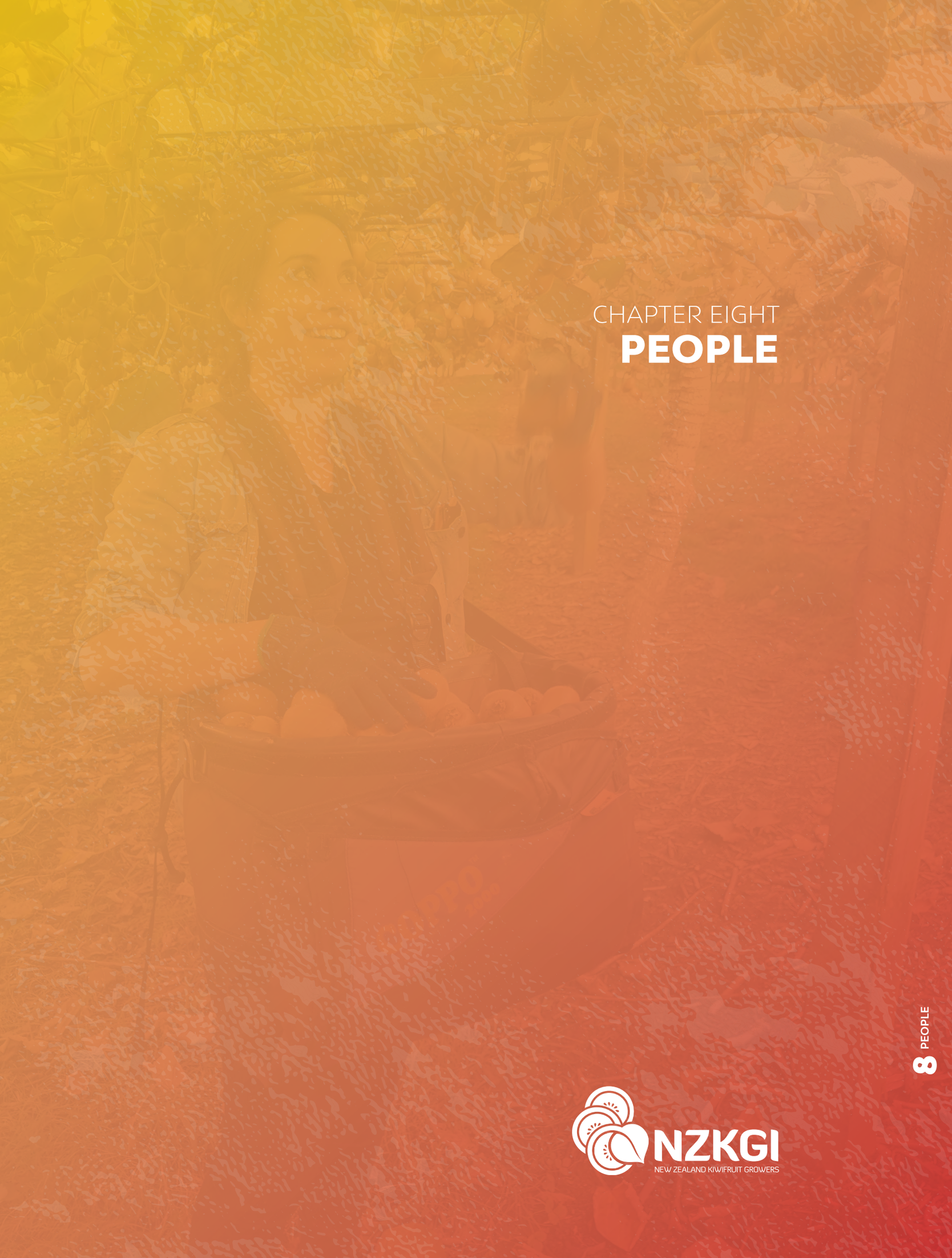
7.3.6 Lights-out Coolstore Automation

The first fully automated coolstore for the kiwifruit industry was opened in May 2019 by EastPack. An investment of $10m, the new coolstore is termed a 'lights-out' coolstore – it has no people inside it and works with a series of robotics and artificial intelligence to check, move and position pallets of fruit into two rooms, each with a tall tower of racking that reaches 14m or 5 levels high. The entire structure is 51m by 41m and 18.2m high. It has the capacity to store 1.2 million trays of fruit and was built in response to the huge growth of fruit volume anticipated in the next five years (see image on next page).

7.4 MANAGEMENT OF FRUIT TO MARKET

Much of the New Zealand grown fruit travels by sea to markets in the northern hemisphere. Travelling this distance requires careful temperature management, monitoring and adjustment to ensure the fruit arrives in peak condition, closer to eating ripeness to delight kiwifruit consumers.

Zespri's quality monitoring programmes include the use of temperature monitors in combination with fruit monitoring by technicians – a combination of sensor data and human judgement to make complicated decisions.



CHAPTER EIGHT

PEOPLE

NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER EIGHT
PEOPLE

It is estimated the industry will need another 7,000 seasonal employees in order to reach its growth targets of 229 million trays by 2029. However, this future growth is dependent on the ability to attract and retain people. This chapter will cover topics such as labour, health and safety and examine industry regulations to show how stakeholders can look after one of the industry's most important resources: Its people.

THE SECTION IS DIVIDED AS FOLLOWS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8.1 LABOUR

Employment Statistics

A 2019 NZKGI survey found there were 19,500 seasonal workers employed in the kiwifruit industry which is forecast to expand to 28,397 people by 2031. As the kiwifruit industry strives to take advantage of increased global demand, shortages of seasonal labour continue to be a challenge. Prior to the advent of Covid-19 in 2020, 53.5% of seasonal workers were New Zealanders, 13.5% were RSE workers and the rest were made up of non-RSE visa holders e.g., backpackers on working holiday visas and international students. Border closures in 2020 drastically reduced the inflow of foreign workers but provided opportunities for New Zealand workers displaced from their jobs by Covid-19. The availability of foreign workers continues to be impacted by travel restrictions, with even fewer expected to be available for the 2022 harvest.

Current estimations are that there are around 9,250 people in permanent employment in the kiwifruit industry. This number will also need to increase as the industry expands. Read more in Ch 9 about initiatives to encourage more people into kiwifruit careers.

Recognised Seasonal Employer (RSE) Scheme

The Recognised Seasonal Employer (RSE) scheme came into effect in April 2007. The scheme allows the horticulture and viticulture industries to recruit workers from overseas for seasonal work when there are not enough New Zealand workers. There is an administrative limit or cap on the number of RSE places that can be taken up in any one year. This cap was set at 5,000 places when the scheme was established in 2007, but the success of the RSE scheme has led to increased demand from employers and the cap was increased to 14,400 in 2019. Unless employers can show they have preestablished relationships with workers from other countries, they may only recruit workers under RSE policy from the following eligible Pacific countries: Fiji, Kiribati, Nauru, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. Workers must meet health and character requirements and provide evidence of arrangements to leave New Zealand at the end of their stay. People employed under the RSE policy may stay in New Zealand for up to seven months during any 11-month period. Exceptions to this are workers from Tuvalu and Kiribati, who can stay for nine months because of the distance from New Zealand and the cost of travel.

"Current estimations are that there are around 9,250 people in permanent employment in the kiwifruit industry. This number will also need to increase as the industry expands."

Right:
In 2019, 14,400 RSE workers came to New Zealand

At the 2018 RSE Conference, then Immigration Minister Iain Lees-Galloway issued four challenges to RSE Employers:

- Make the industry more attractive to New Zealand workers, by providing better wages and conditions
- Build more accommodation for workers to alleviate local accommodation pressures
- Take greater responsibility for supply chains and labour contractors to help stamp out migrant exploitation
- Transform the horticulture and viticulture industries from low-cost industries to industries based on quality, productivity, and high value products.

These challenges have led to a number of initiatives and shaped the Horticulture Industry transition plan. An additional comment from Minister Lees-Galloway was around the need for Horticulture to work with other industries by sharing knowledge and experience, as it is acknowledged that many industries, such as construction and hospitality, are also experiencing a shortage in labour supply. Benefits may come from coordinating with other industries with complementary peak labour periods.

In Kiwifruit, it is recognised that the working conditions granted to RSE workers have led to an overall increase in conditions for all workers. In 2021, most packhouses paid the living wage to all workers (rather than just minimum wage), and on-orchard pay rates have traditionally been higher. The RSE scheme also contributes to New Zealand's objectives for the Pacific, by encouraging economic development, regional integration and stability. In 2018, the RSE scheme saw the Pacific Islands benefit by more than $40 million. The RSE scheme has also been recognised by the World Bank as being one of the best migrant labour schemes in the world.

For more information about the importance of the RSE scheme to the Pacific Island participants see **www.hortnz.co.nz/people-jobs-and-labour/rse-scheme/** for a series of short videos.

Becoming a Recognised Seasonal Employer (RSE)

New Zealand horticulture and viticulture employers can apply to Immigration NZ to become RSEs and recruit overseas workers only when there are not enough New Zealanders to plant, maintain, harvest and pack their crop. The employers must fulfil certain requirements to be considered as RSEs:

- Show evidence of being in a sound financial position
- Have human resource policies and practices that are of a high standard, promote the welfare of employees, and include a dispute resolution process
- Have demonstrated a commitment to recruiting and training New Zealanders
- Show evidence of good workplace practices, including compliance with all immigration and employment laws (e.g., health and safety policies and procedures)

Once granted RSE status, Employers then apply for an Agreement to Recruit (ATR). Additional criteria must then be met:

- Show evidence of the shortage of labour in their region and the number of positions they need to fill
- Show how RSE workers pastoral care will be catered for e.g., transport to and from their port of arrival, a work induction program, access to acceptable medical insurance, access to personal banking, necessary language translation, opportunities for recreation and religious observance.
- Provide suitable accommodation at a reasonable price, which does not take away residential accommodation for New Zealanders.
- While employed, RSE workers must be provided with transportation to and from the worksite, all safety equipment and personal protective equipment (PPE), onsite facilities (toilets, handwashing, shelter, first aid, fresh drinking water)
- Provide sample employment agreements that include paying the market rate for the work carried out by RSE workers, specify hourly rates and piece rates that apply, guarantee minimum payments (e.g. at least $22.10/hr, for a minimum of 30 hours/week), detail any deductions, comply with NZ Employment Law.
- Agree to cover the cost of repatriation if workers breach their visa conditions

Once granted an ATR, Employers can then offer jobs to seasonal workers from overseas. They support their workers visa applications by providing written employment agreements that meet all necessary criteria.

An initial RSE status is granted for 2 years, with subsequent applications approved for 3 year durations.

For more detailed information about applying for RSE status see **https://www.immigration.govt.nz/documents/forms-and-guides/inz1140.pdf**

Looking forward from 2020

With the March 2020 lockdown, many RSE workers already in the country were unable to return home, and many others that were expected to arrive were excluded (along with foreign backpackers). This changed the mix of workers for the 2020 kiwifruit harvest, with the industry making up the balance with New Zealanders that had been displaced from their previous jobs (see Ch1.9 Industry response to Covid-19). Immigration New Zealand had to modify visa conditions for those RSE's remaining and they were kept in employment as much as possible. Repatriation flights to the Pacific Islands were able to go ahead later in the year, but some RSE workers chose to remain in New Zealand. The Government retained the 14,400 cap in 2020, but under Covid-19 border restrictions only 2012 RSE workers entered the country in January and February 2021, through MIQ facilities. These workers were shared between horticulture and viticulture employers around New Zealand. More are expected to arrive by harvest 2022 with the Government allowing some quarantine free travel for workers from Vanuatu, Tonga and Samoa. However, the planning around this remains fluid as a result of the Delta variant outbreak in New Zealand.

With ongoing border closures preventing working holiday visa holders from entering, fewer RSE workers available, an unemployment rate sitting around 4-4.5%, and a forecast crop increase of 10-15 million trays from 2021, the industry is predicting and planning for a severe labour shortage in 2022.

This challenge is being approached from a number of directions:

1. **Attraction:** NZKGI's labour attraction campaign has been in place for a number of years. It involves the use of targeted media (including online and traditional print media, and collateral such as flyers and posters) to promote seasonal jobs to different groups (such as students, retirees, sports clubs). The messaging also includes links to job sites for recruitment. At the end of each year the strategy is reviewed, using the quantitative data available from the social media platforms and worker surveys, and refined for the next year's campaign. Other attraction activities have included Government-funded training courses to give potential employees some preliminary skills and a taste of the job, so they know what they are signing up to.

   For more information on this attraction strategy go to **www.nzkgi.org.nz/wp-content/uploads/2020/09/2020-Labour-Attraction-Strategy-Evaluation.pdf.**

2. **Retention:** the 2021 harvest was notable for a perceived increase in absenteeism by some businesses, ranging from 0-50%, with a median around 20%. This included workers signing up but not turning up to work, some not completing whole shifts, or working less shifts per week than they were contracted for. Although widespread across both on-orchard and postharvest operations, this was not an industry-wide issue, suggesting that further research into the motivators driving this behaviour is warranted. This research is currently ongoing.

3. **Government Policy:** early indications are that the welfare system may be a factor contributing to absenteeism. By its nature, seasonal work is fixed term, and attention needs to be focussed on the threshold for benefit levels to be impacted by income changes, for both students and job seekers. Employment Law should also be scrutinised, to provide more flexibility around working while studying or working longer hours during peak times, providing more opportunity for workers to transition from fixed term to permanent contracts.

4. **Automation** provides another potential solution for the labour shortage, allowing replacement of unskilled roles with machines that are more efficient and stainable. This necessitates a transition to a more highly trained and skilled workforce to maintain the technology. Read more in Ch 7 about automation across the kiwifruit value chain.

   To read more on the shortage of seasonal labour, read the NZKGI Seasonal Labour Report for the 2020 season on the NZKGI website at **www.nzkgi.org.nz.**

Thompson's Horticulture Limited

Thompson's Horticulture Limited (THL) is a family run and operated business that owns and manages vineyards and kiwifruit orchards in the East Coast region. Like other similar companies in the horticulture sector, THL has been heavily reliant on casual labour. However, unreliability of some staff made day-to-day management of the workflow problematic. Absenteeism was frequent and unpredictable. Losing casual staff meant constant retraining when replacement labour was sourced.

Four years ago, THL made the decision to have a people focus in its business, with the aim to become a preferred employer. A key aim was to be able to be flexible for staff and provide the business with surety of labour. It consulted with staff and worked with the Labour Inspectorate to structure new employment contracts. Employees are guaranteed at least one day of 8 hours a week. In return they agree to be at work at least one day each week. A range of employee benefits has helped foster loyalty to the employer.

THL runs a highly successful employment and training programme, partnering with the Ministry of Social Development (MSD) and Eastern Institute of Technology (EIT). Long term unemployed are recruited by MSD to join the programme where they are offered a 5-month fixed term contract with THL, working as Horticulture Workers. Through a combination of on-the-job training and classroom learning, participants can gain the NZ Certificate in Primary Industry Skills (Level 2) through EIT. More than 80 people have been put through the programme since it was launched.

The classroom part covers literacy, numeracy, and the theory behind the horticultural tasks they perform while working on the kiwifruit vines. Programme participants are considered part of THL's core labour force for the duration of their training. At the conclusion of the programme, workers can apply for a Permanent, Fixed Term or Casual position with THL. Feedback received was that the experience of being in the programme had given them confidence to re-join the workforce. Successes included a participant who was encouraged to undertake further training after THL staff noticed her positive attitude and work ethic. She was highly motivated by the experience and is now a THL Supervisor and a valued employee. She had also introduced other members of her family to the company. THL says it has been able to attract trustworthy and reliable workers because of the success and reputation of the programme.

A Horticulture Apprenticeship programme is also run at THL. Employees work towards completing their NZ Certificate in Horticulture (Fruit Production) (Level 3 & 4). This programme offers a pathway to management. Successes include a trainee who began working for THL in the machinery area, went on to become a Trainee Horticulture Manager, and is now the Development Manager who has developed 50ha of kiwifruit in Gisborne.

THL launched an initiative to give permanent staff an opportunity to obtain their driver licence free of charge. The company had become aware that some employees, who travelled to work by car, were unlicensed drivers. One, who was on a restricted licence, had been bringing several others to work in their vehicle. THL uses the services of outside providers in Gisborne and Opotiki to deliver training so employees can obtain their driver licence at no cost. This includes theory, driving lessons and a defensive driving course. THL is focused on investing in its people. It says the ability to obtain a driver licence has helped dispel the frequently held belief that employers do not care about staff.

8.2 HEALTH & SAFETY

The Health and Safety at Work Act 2015

The Health and Safety at Work Act 2015 (HSWA) is New Zealand's workplace health and safety law that came into effect on 4 April 2016 and is part of a reform package aimed at reducing the number of serious work-related injuries and deaths. The HSWA shifts the focus from monitoring and recording health and safety incidents to proactively identifying and managing risks so everyone is safe and healthy.

HSWA ensures that everyone has a role to play and makes everyone's responsibilities clear:

- Businesses have the primary responsibility for the health and safety of their workers and any other workers they influence or direct. They are also responsible for the health and safety of people at risk from the work of their business. Officers (company directors, partners, board members, chief executives) must do due diligence to make sure the business understands and is meeting its health and safety responsibilities.
- Workers must take reasonable care for their own health and safety and that their actions don't adversely affect the health and safety of others. They must also follow any reasonable health and safety instruction given to them by the business and cooperate with any reasonable business policy or procedure relating to health and safety in the workplace.
- Other people who come into the workplace, such as visitors or customers, also have some health and safety duties to ensure that their actions don't adversely affect the health and safety of others.

More information can be found in the 'Keep safe, keep growing' guide on the WorkSafe website:

https://worksafe.govt.nz/topic-andindustry/horticulture/keep-safe-keepgrowing-how-to-be-healthy-and-safe-in-horticulture/

NZKGI & Zespri Health & Safety Guidance Material

In collaboration with Zespri, NZKGI has created guidance material to help growers understand their obligations as a PCBU ('person conducting business or undertaking') on the orchard. This four-step guide sets out the steps growers need to take to manage their health and safety obligations on the orchard and includes a decision tree for growers to confirm their role as a PCBU. The Health & Safety wheel and associated materials are located on the NZKGI website at:

https://www.nzkgi.org.nz/what-we-do/health-safety/

Right:
A typical Health & Safety briefing on orchard.

8.3 CERTIFICATION FOR GLOBALG.A.P. AND GRASP

Putting Food Safety and Sustainability on the Map

G.A.P. stands for Good Agricultural Practice, and GLOBALG.A.P. is the worldwide standard that assures it. GLOBALG.A.P. is a global organisation with a crucial objective: safe, sustainable agriculture worldwide. GLOBALG.A.P. is an important aspect of orchard management affecting everyday activities around growing kiwifruit. Further, it is a compliance programme with a range of modules growers must complete to meet the industry standard and achieve certification.

GLOBALG.A.P. has mandatory requirements that follow legislation and voluntary requirements that promote best practice. However, although the organisation has set voluntary standards for the certification of agricultural products around the world, an increasing number of producers, suppliers and buyers are aligning their certification standards to match. There are a range of activities growers must adhere to in order to achieve certification, from good record keeping through to correct spray management practice.

There are two certification options for New Zealand kiwifruit growers:

Option 1 certification - For a single producer (with or without a Quality Management System).

- Growers that need certification for multiple crops must be option 1
- Less than 100 kiwifruit Management System Owners (MSO) are option 1 certified
- MSO's get their own GLOBALG.A.P. certificate

Option 2 certification - Multiple producers with a mandatory Quality Management System (Group certification).

- A group of producers with a shared mandatory Quality Management System (QMS) receives one certification for the entire group following a successful audit of the QMS and random sample inspections of some of the producers by a GLOBALG.A.P. approved certification body
- Option 2 is Crop specific meaning option 2 covers kiwifruit only
- Over 95% of New Zealand's kiwifruit growers are certified through option 2

GLOBALG.A.P. and GRASP for Kiwifruit Contractors

Contractors have a vital role within the kiwifruit industry and therefore play a major part in growers' G.A.P. compliance. Growers are required to ensure that everyone working on the orchard is compliant with G.A.P. requirements at all times.

For G.A.P. purposes, a contractor is defined as anyone hired to undertake work that is addressed by one or more requirements in the G.A.P. and GRASP checklists. This includes all contractors and sub-contractors.

All kiwifruit contractors are required to be inspected against the orchard activities that they take part in. They

are also responsible for ensuring that anyone they employ complies with these requirements. It is also the contractor's responsibility to ensure that all requirements as set by legislation are met, specifically in regard to health, safety and employment. Contractors must provide the grower with a CAV (Compliance Assessment Verification) issued by an approved inspector before they undertake any work. These need to be kept on file by the grower for their inspection.

Food safety is also a critical part of some contractor operations. On entering the orchard, contractors and their employees must be healthy and adhere to good hygiene practices whilst handling fruit in order to avoid contamination of the product or the spread of disease. Contractors are responsible for ensuring that orchard hygiene procedures are adhered to, that all staff are appropriately trained, that risk assessments are undertaken, and that training is documented.

> "GLOBALG.A.P. is an important aspect of orchard management affecting everyday activities around growing kiwifruit."

GRASP

A Commitment to Workers Health, Safety and Welfare

GRASP stands for GLOBALG.A.P. Risk Assessment on Social Practice and is a voluntary social responsibility module of GLOBALG.A.P. GRASP was developed to assess social practices on the orchard and the module consists of 11 questions which can be added to the annual GLOBALG.A.P. audit. GRASP is an assessment only, not a full social audit.

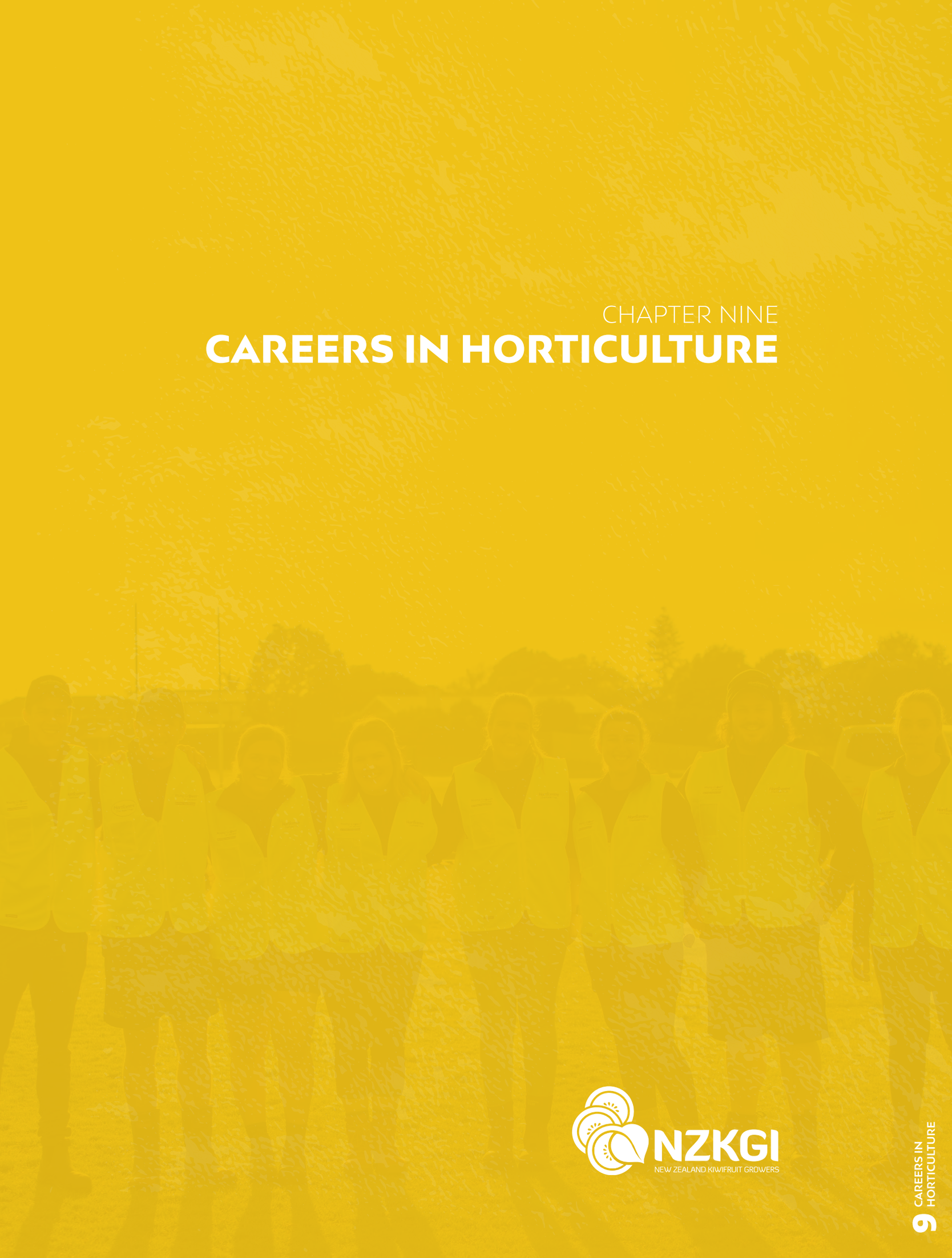
During the GRASP Assessment, the Following Topics are Checked:

1. Confirmation that there is an Employees' Representative
2. Confirmation that there is a complaints procedure for employees
3. Self-Declaration from the orchard owner on good social practices (including commitment to the International Labour Organisation core labour conventions)
4. Access to national labour regulations for workers
5. That workers have signed contracts (employment agreements)
6. That there are regular payments of employees' wages, with evidence (pay slips)
7. Payment of at least national minimum wage
8. Non-employment of minors
9. That children of workers who live on the orchard have access to compulsory school education
10. Time recording system for employees
11. Safe working hours and adequate breaks

GRASP helps growers establish a good social management system on their orchard. It offers consumers added assurance that they are purchasing a product that has been ethically produced. And it helps protect one of the orchards most important resources: Its people.

CHAPTER NINE

CAREERS IN HORTICULTURE



NZKGI
NEW ZEALAND KIWIFRUIT GROWERS

CHAPTER NINE
CAREERS IN HORTICULTURE

A career in horticulture is not just about growing, picking and packing fruit. There are an increasing number of highly valued roles available in the scientific, business and technology sectors servicing production horticulture. People enter the kiwifruit industry through many different pathways – from seasonal workers in the orchards or packhouses, through to graduates with specific degrees. At every level there is training available to upskill and build a rewarding career. This chapter includes a career map displaying the wide range of opportunities available. There are also biographies of industry entrants to show the pathways they took to get where they are today.

THE SECTION IS DIVIDED AS FOLLOWS

Horticulture Career Progression Managers Network

Te Ara Mahi

Who we are

A network of 9 managers working across New Zealand to increase the number of people pursuing careers in horticulture, so the industry can continue to grow and prosper

Regions

Northland
Pukekohe
Bay of Plenty
Hawkes Bay
Manawatu
Nelson/Tasman
Canterbury
Central Otago

How we work

Our role is to promote career opportunities within the fruit and vegetable industry.

We connect people to our industry, education providers, and government agencies.

We bridge the gap between education, training, and employment.

We promote horticulture careers to New Zealanders by showcasing opportunities in our diverse and vibrant industry.

We help New Zealanders decide on the training that is right for them and work out their career progression pathway.

To achieve

The right people for the right job - a work force with the right training and attitude, advancing their horticulture careers and our industry

Contact

To contact a career progression manager visit https://gohorticulture.co.nz/contact/

9.1 CAREER PROGRESSION MANAGERS

Horticulture New Zealand recognised that growth in all horticultural sectors is driving a strong demand for skilled people to take on existing and future roles within the industry. Initially with funding from the Provincial Growth Fund (PGF), a network of Regional Career Progression Managers was set up. This team has now grown to nine people, positioned in the largest growing areas in the country (Northland, Pukekohe, Bay of Plenty, Hawke's Bay, Nelson/Tasman, Canterbury and Central Otago) They have been tasked with increasing the numbers of students entering into full time study, industry training, and employment in the horticulture and viticulture sectors. They work with schools, tertiary education and vocational training organisations, industry employers and government agencies to highlight the pathways for people to find rewarding careers within the horticultural industry.

GoHort has become the brand for the Career Progression Managers, with an online presence at t https://gohorticulture.co.nz/

On this site you will find

- Descriptions of different roles
- Career pathways
- Training providers and the courses they offer
- Horticulture sector specific information and links
- Profiles of people in the horticulture industry
- Details of GoHort internships and how to apply.
- A job board for employers to advertise permanent roles in the industry
- Contact details for the Regional Career Progression Managers
- Resources for teacher to use

9.2 AGRIBUSINESS IN SCHOOLS

In 2013, St Paul's Collegiate (Hamilton) designed and developed a pilot Agribusiness Programme to encourage their own secondary students to consider career pathways in the primary sector. In the first year it attracted 44 students across years 12 and 13. From this beginning, the school established an Agribusiness Advisory Group made up of key representatives from across the primary sector and attracted business partners to help fund the work they were undertaking. With input from these groups the Agribusiness national curriculum was developed, with achievement standards at NCEA level 2 and 3, supported by the Ministry of Education (MOE). This is the only secondary curriculum developed in conjunction with industry rather than written by the MOE.

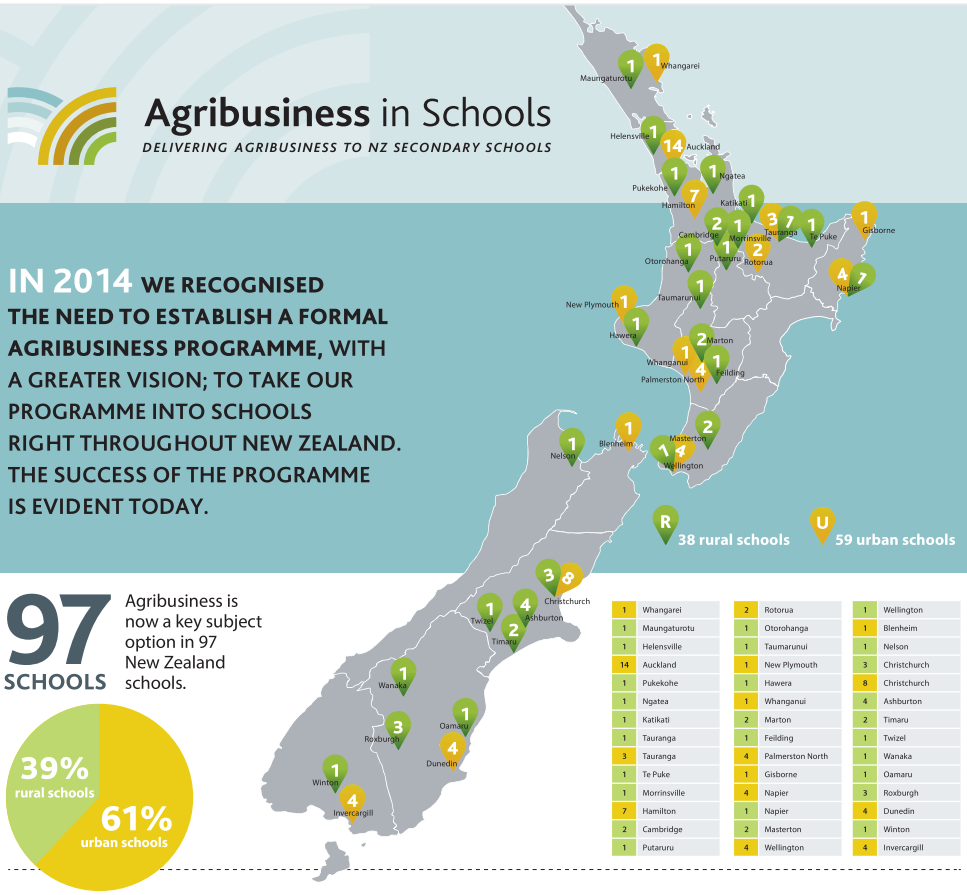
To date St Paul's has made the Agribusiness programme available to 97 secondary schools in New Zealand, with the majority in urban rather than rural areas. Many of these schools have also seen an uptake in Ag/Hort as a subject, with the recognition that the primary sector is a dynamic growth area with many opportunities. There have been corresponding increases in entrants to related university courses. Now in its 8th year, the primary sector is starting to see young graduates from the programme entering the workforce.

For more information about the Agribusiness programme see https://agribusiness.school.nz

Agribusiness in Schools

DELIVERING AGRIBUSINESS TO NZ SECONDARY SCHOOLS

IN 2014 WE RECOGNISED THE NEED TO ESTABLISH A FORMAL AGRIBUSINESS PROGRAMME, WITH A GREATER VISION; TO TAKE OUR PROGRAMME INTO SCHOOLS RIGHT THROUGHOUT NEW ZEALAND. THE SUCCESS OF THE PROGRAMME IS EVIDENT TODAY.

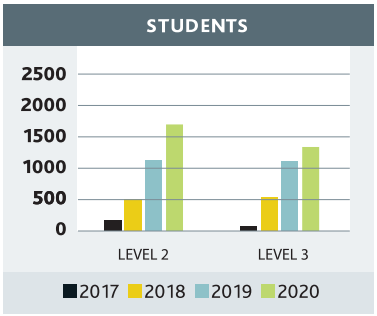


1	Whangarei	2	Rotorua	1	Wellington
1	Maungaturotu	1	Otorohanga	1	Blenheim
1	Helensville	1	Taumarunui	1	Nelson
14	Auckland	1	New Plymouth	3	Christchurch
1	Pukekohe	1	Hawera	8	Christchurch
1	Ngatea	1	Whanganui	4	Ashburton
1	Katikati	2	Marton	2	Timaru
1	Tauranga	1	Feilding	1	Twizel
3	Tauranga	4	Palmerston North	1	Wanaka
1	Te Puke	1	Gisborne	1	Oamaru
1	Morrinsville	4	Napier	3	Roxburgh
7	Hamilton	1	Napier	4	Dunedin
2	Cambridge	2	Masterton	1	Winton
1	Putaruru	4	Wellington	4	Invercargill

97 SCHOOLS Agribusiness is now a key subject option in 97 New Zealand schools.

The numbers of students learning and schools teaching Agribusiness have consistently increased over the last four years.

YEAR	LEVEL 2 STUDENTS (YEAR 12)	LEVEL 3 STUDENTS (YEAR 13)
2017	173	87
2018	529	570
2019	1121	1120
2020	1728	1329



***Unit standards and achievement standards** are two types of assessments schools use to assess student knowledge. Both standards specify what a candidate needs to know, do, and understand.*

***Unit standards** are competency based and usually vocational based assessment, developed by the relevant industry training organisations such as the PrimaryITO. Schools need to be accredited to assess unit standards by the relevant industry training organisation. There are just two grades; Achieved (A) for meeting the criteria of the standard and Not achieved (N) if a student does not meet the criteria of the standard.*

***Achievement standards** are based on assessing New Zealand curriculum developed by the Ministry of Education. Achievement standards are measured by four grades; Achieved (A) for a satisfactory performance, Merit (M) for very good performance, Excellence (E) for outstanding performance, and Not achieved (N) if students do not meet the criteria of the standard.*

Partnering with secondary schools in New Zealand to teach Agribusiness

St Paul's COLLEGIATE SCHOOL

DairyNZ Profitability. Sustainability. Competitiveness.

beef+lamb new zealand

Profile: Pioneer Student of Agribusiness

After growing up on a dairy farm and kiwifruit orchard in the Bay of Plenty, Kate Wilkins thought she would never pursue a career in horticulture. But after studying Agribusiness at St Paul's Collegiate School, she discovered the world of opportunity in New Zealand's primary sector.

The 25-year-old is now an Extension Delivery Specialist at Zespri, the world's largest fruit marketer.

The company sells kiwifruit to more than 50 countries around the globe and has licensed growers in Italy, France, Japan, and South Korea.

"Having grown up around agriculture and horticulture I wasn't sure if I wanted a career in the sector. It was 'normal' and not exciting to me, and after working in the summer holidays in the kiwifruit orchard I didn't want to ever work in an orchard again," laughs Kate.

Kate studied Agribusiness in Year 12 and 13 at St Paul's, starting in 2014 when the course was still in its infancy.

St Paul's established the agribusiness programme to meet the primary industry's needs for engaged, well-qualified young people, enthusiastic about their career opportunities in the primary sector. NZ Kiwifruit Growers Inc have partnered with the Agribusiness in Schools project which is now being taught in 97 schools nationally, catering to 3057 students in 2020.

Kate had always enjoyed economics and accounting and with a farming background she says Agribusiness seemed like a natural progression for her.

"Studying Agribusiness at St Paul's really opened my eyes to the multitude of career opportunities within the primary industry, which didn't just include working out on an orchard or on farm," she says.

Kate found the course offered students access to industry leaders and she remembers guest speakers including Richard Burke, General Manager of LeaderBrand, which is New Zealand's most diverse horticulture business. She says their presentations and the curriculum provided insights across the entire value chain of the primary industry.

After finishing high school, Kate enrolled for a Bachelor of Commerce at Canterbury University, but by the second semester she decided to shift to Lincoln University to study a Bachelor of Commerce Agriculture.

"I could see a clear career path. It was economics and accounting, but it also took in the supply chain, animal science, plant science and soil science. It gave me a sense of purpose around what I wanted to do," says Kate.

When she graduated in 2017, Kate returned to work on her family's farm. She set about establishing a new 12-hectare organic gold kiwifruit orchard to add to the six hectares of gold and green orchards they already had.

It was while establishing the new orchard Kate found her niche.

"We had a lot of people through the orchard at that time, including people from Zespri, because what we were doing was new and fresh."

Kate was offered a role in Zespri's Extension team.

As an Extension Delivery Specialist Kate says she is now focused on creating positive change in New Zealand's kiwifruit industry.

"We're supporting and inspiring growers to produce the world's best kiwifruit, whether that's through changes in sustainability practices, production practices or even health and safety. No two days are the same," says Kate.

She loves that it's not a typical office job and that she can get out in the field and see the impact her work is having on growers.

"I love the interaction with growers and using my knowledge to provide them with advice or solutions to problems. One day I can be running a field day and the next day I'm writing a newsletter or talking to growers about nutrient management and irrigation methods."

For anyone thinking about taking Agribusiness Kate encourages them to go and research the jobs on Seek.

"Search roles in Agribusiness and see the jobs that come up. You'll soon realise it's not all on a farm or in an orchard," says Kate.

9.3 HORTICULTURE CAREER PATHWAYS

START HERE FOR A POST HARVEST CAREER

Post Harvest Worker

Grower Advisor

Grower Liaison

Grower Liaison Manager

Quality Controller

Quality Control Supervisor

Quality Control Manager

Grader

Packer

Leading Hand

Grade Supervisor

Coolstore Operator

Packing Line Supervisor

Quality Control Manager

Packing Line Manager

Logistics Manager

Coolstore Supervisor

Coolstore Manager

Packhouse Manager

Senior Manager

GENERAL MANAGER

Orchard Manager/Contractor

Leading Hand Supervisor

Team Leader Machinery Operations

Tractor Driver; Agrichemical Spray Application and Forklift

Begin cadetship or apprenticeship

Tractor Driver Operate Mower & Mulcher

Orchard Technician, Specialised Plant Husbandry, Grafting & Frost Protection

START HERE FOR AN ENGINEERING CAREER

OBTAIN A ENGINEERING DEGREE:
ROBOTICS/AUTOMATION
SOFTWARE DEVELOPMENT
PRODUCT DEVELOPMENT

Research & Development Engineer

Junior Engineer

START HERE FOR AN ORCHARD CAREER

Orchard Worker - Harvesting, Plant Care and Construction

GROWER DIRECTOR CEO

GENERAL MANAGER

Senior Manager

Software Development

Senior Manager

Office Manager

Executive Assistant

Administrative Assistant

Senior Accountant

Junior Accountant

Financial Manger

Senior Business Analyst

Business Analyst

Marketing/Sales Manager

Marketing Sales Coordinator

Marketing/Sales Executive

Senior Manager

Human Resources Manager

Supply Chain Manager

Human Resources Advisor

Communications Manager

Human Resources Coordinator

Supply Chain Coordinator

Communications Coordinator/ Advisor

Scientist

Research Associate

Electronic Data Interchange Supervisor

Technician

Electronic Data Interchange Operator

START HERE FOR A SCIENCE CAREER

OBTAIN A SCIENCE DEGREE:
BIOLOGICAL SCIENCES
FOOD SCIENCE AND NUTRITION
MICROBIOLOGY
ENVIRONMENTAL SCIENCES
DATA SCIENCE

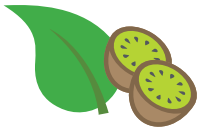
START HERE FOR A BUSINESS CAREER

OBTAIN A BUSINESS DEGREE:
HUMAN RESOURCES COMMUNICATION
MARKETING
FINANCE/ACCOUNTING
BUSINESS ADMINISTRATION
SUPPLY CHAIN

As indicated in the horticulture career map on the previous page, there are many ways to enter the industry whether it be through direct employment, part time study alongside employment, or full-time study.

Direct Employment

Roll up your sleeves and hit the ground running by entering the industry directly to get valuable work experience. Once you are in the industry, many employers offer upskilling and study opportunities so that you can advance on the job.



Part-Time Study/Employment

Earn while you learn by working within a kiwifruit orchard, packhouse or kiwifruit-related business as well as studying. There are vocational study options to suit everyone from Level 1 Horticulture or Primary Industry courses, through to cadetships, apprenticeships, and advanced Level 5/6 certificates and diplomas.

Full-Time Study

University study in any of a wide range of subjects, from business, engineering or technology to science or horticulture, can lead to a career in the kiwifruit industry. Many scholarships are available to assist with fees and expenses.

Young Grower Competition

There are many opportunities for development and upskilling of people in the kiwifruit industry and the wider horticultural sector. Since 2007, Horticulture New Zealand has run the annual Young Grower of the Year competition. Young fruit and vegetable growers from around the country compete in regional heats, testing their horticultural skills and knowledge in both practical and theory challenges (see the 2021 BOPYG contestants at the front of this chapter). The winners of the regional competitions then compete in the national final. Young Grower pushes contestants out of their comfort zone and teaches them valuable new skills along the way. The competition provides exceptional professional development and networking opportunities, providing a massive career boost to all who enter. Criteria for entry:

- Must be currently working full time in the fruit or vegetable industry in an organisation that is closely associated with growing.
- Must be 30 years of age or under as at 31 December.
- Three years practical work experience in the industry.
- Must be a New Zealand citizen or hold a current New Zealand residency permit

The next page will provide career profiles of people currently working in the kiwifruit industry, each with a unique story of their pathway.

9.4 CAREER PROFILES

CAMPBELL WOOD

Role/Organisation: ***Director of Pivot Horticulture***

Pathway: ***Cadetship/Apprenticeship/Further Industry Study***

What I enjoy about this industry is the diversity of working with lots of people coming from a range of cultures and places around the world. The kiwifruit industry offers a huge range of professional development opportunities which have helped advance my career and I am passionate about attracting young people to the industry so that they too can experience the amazing opportunities that are available.

What I like to tell younger versions of myself deciding what career path to take is this:

- Knuckle down and stick to an industry - ride out the highs and multiple lows
- Do the hard yards - work harder than expected, invest in doing more than required, don't be afraid "to sweep the factory floor"
- Push yourself out of comfort zone on a regular basis - take on challenges where you think you're out of your depth and own the outcome be it positive or negative

JEFFREY BENFELL

Role/Organisation: ***Human Resources Assistant, Apata***

Pathway: ***Direct Employment***

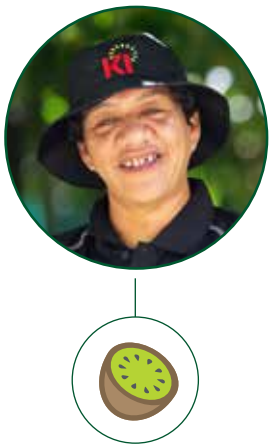
After 20 years in the travel industry, I was made redundant at the start of the Covid-19 pandemic. I made a call to a friend in the industry that led to me being hired by Apata as a human resources assistant, starting just as the country headed into lockdown Alert Level 4. My role covers the full scope of human resources, from recruitment to attendance, so I was able to transfer many of my skills I learned in decades in customer service. Almost anyone can work in some capacity in kiwifruit. For stackers, it's quite a physically demanding job. For graders, its mentally focused. And for tray preparation and packers, it takes a lot of skill, thought and speed. Apata pack both kiwifruit and avocadoes. Because we have both it keeps a lot of our people in very good employment for 10 months of the year.

WAI DE FLAVELLE

Role/Organisation: ***Inventory and Logistics Coordinator at EastPack***

Pathway: ***Direct Employment***

I started out in the industry working in the packhouse at EastPack located in Te Puke and within those five years I have worked in a range of roles including Packer, Packhouse Team Leader, Allocations Coordinator, Field Technician, Crop Assessment Team Leader, Inventory Assistant and finally to my current role as Inventory and Logistics Coordinator. I have found that in this industry, if you are a hard worker you can progress very quickly! There are so many opportunities within the kiwifruit industry to learn, grow and develop a meaningful career.



STACEY MARINO

Role/Organisation: ***Orchard Supervisor, Kiwifruit Investments***

Pathway: ***Direct Employment***

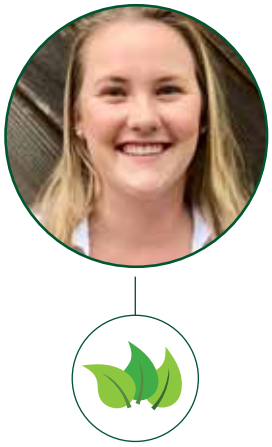
I started as a packer and then a grader in the packhouse. After my first harvest I stayed on and did the re-pack season. The following year, I got asked to be a packaging supervisor, teaching others the skills I learnt in packing and grading. The industry has an array of jobs and so many areas to branch off in, whether it's in the packhouse or the orchard. I tried fruit thinning the next year and loved it even more than being in the packhouse because I enjoy being outdoors. Supervisors and managers will spot you out and advance you. They put a lot into helping people, and giving them different skills and areas to work in. I really enjoy the work because it's always changing, and I enjoy teaching people. I love learning new things, and the industry is always evolving.

GAVIN STAGG

Role/Organisation: ***Labour Coordinator, New Zealand Kiwifruit Growers Incorporated***

Pathway: ***Direct Employment***

Until I joined the kiwifruit industry, the longest I'd held a job was two years. In this business, no two days are the same, so it keeps me interested! Prior to kiwifruit, I trained as a chef, joined the army, and held various other positions, mostly managing people. My first role in kiwifruit was as an employment officer for a packhouse. As my industry knowledge grew, I was promoted to Packhouse Operations Manager in a year. From there, I secured a new role as an Operations Manager for a different packhouse which involved managing the entire site. I left that role in early 2019 to start my current role with NZKGI. The highlight of this role is the different people that I get to interact with, from contractors, growers and packhouses through to government agencies.



MEGAN FOX

Role/Organisation: ***Orchard Technical Advisor, Southern Cross Horticulture***

Pathway: ***University Degree***

I love working in the kiwifruit industry because there is a huge network of supportive people both within my workplace, and externally, that are always willing to lend a hand or impart valuable knowledge. Further, it is an exciting industry to be a part of as there are a lot of opportunities to move laterally across the industry as well as huge potential to move up very quickly. Currently we are planting 700ha per year of G3, and the average orchard manager is managing 50ha, meaning we need to hire 14new orchard managers every year to help with our growth- the demand for skilled labour is huge. I would recommend anyone to consider entering the kiwifruit industry to gain access to some amazing career opportunities!

9.5 'DIARY OF A GRADUATE KIWIFRUIT TECHNICIAN'

Written by Ben Luke, Zespri

With a last-minute position needing to be filled, I was given the call up to spend two weeks at sea monitoring 1.2 million trays of kiwifruit bound for Japan. With three days' notice I fervently prepared for the journey. I underwent intensive training with the Zespri team and spent the night before boarding watching 'Captain Phillips' to prepare for the worst and to potentially pick up some handy tips if any pirates boarded. Fresh faced, nervous yet excited, I was ready to board the Atlantic Erica on 3 June.

Right:
Ben Luke standing next to the Atlantic Erica

I soon got into the swing of things on board with the Filipino crew, with a typical day beginning by avoiding mysterious goo covered meats or fish for breakfast, and instead chowing down my trusty cereal and milk. After breakfast, I would hike up three flights of steep stairs to the bridge to see the Chief Officer. He would organise one of the crew to accompany me down into the cargo holds and let me know if the conditions were safe enough to collect the fruit for assessment. The monitoring process included collecting a total of 320 pieces of fruit, both green and gold, from eight different libraries which gave me access to four different pallets from four different grower lines. Before being loaded onto the ship, each library was chosen to ensure it was representative of the hold it was in. It's designed like this so if the temperature in the hold is adjusted based on the monitoring results, the rest of the fruit in the hold should ripen in the same way. The fruit collecting process took me around 50 minutes, which to the crew was probably very slow. It was as if they learnt how to climb ladders before learning how to walk.

I methodically checked the temperature, firmness and brix of the fruit collected which took around seven hours. The crew popped in every now and again to check everything was ok and once I finished testing all the fruit, I filled in my daily log, checked the data, save the file onto a USB stick and took it to the Captain to send back to Zespri New Zealand. The Zespri team in NZ then analysed the results and sent back instructions about any temperature changes to be made in the hold to ensure the fruit doesn't over ripen or ripen too slowly.

> "No communication or sight of land for two weeks was an interesting experience but amazing at the same time."

The highlight of my trip included enjoying a day with the crew on the Captain's birthday. Everyone indulged in a few brews, various meats and took a dip in a self-made pool at the back of the ship. The crew could not have been friendlier to me. Constantly offering me beers, inviting me to watch movies and treating me as if I were one of their own made me feel very welcomed. No communication or sight of land for two weeks was an interesting experience but amazing at the same time. Seeing a log floating in the vast empty ocean half way through the trip even made me excited. I'm not itching to get back on a ship, but it was definitely an experience I will never forget. I certainly have a new-found respect for the team of technicians that come back year after year to spend weeks on end at sea, all to get our fruit to the other side of the world in optimal condition.

Right:
The crew on board Atlantic Erica celebrating the Captains's birthday

APPENDIX

Industry Statistics – Performance and Production by Cultivar, Region and Markets

	2020/21	2019/20	2018/19	2017/18	2016/17	2015/16	2014/15	2013/14
Distribution to growers/suppliers								
Fruit and service payments (excl loyalty premium)	**13.72**	12.94	11.52	11.53	9.21	9.27	9.57	9.02
Loyalty premium	**0.39**	0.31	0.30	0.27	0.25	0.24	0.24	0.24
Total payments per tray	**14.11**	13.25	11.83	11.80	9.46	9.51	9.81	9.26
Crop Volumes (000's)								
Trays submitted (gross)	**160,977**	150,341	157,715	125,822	148,902	123,763	97,304	87,725
Trays supplied	**159,649**	148,134	154,058	124,433	145,871	120,145	95,683	86,510
Trays sold	**158,077**	145,223	148,843	123,246	137,748	117,094	95,187	86,094
Trays sold as a percentage of trays supplied	**99.0%**	98.0%	96.6%	99.0%	94.4%	97.5%	99.5%	99.5%
General Statistics								
Production per hectare (trays submitted)	**12,072**	11,650	12,373	9,913	11,838	10,157	8,662	8,016
Producing hectares	**13,334**	12,905	12,747	12,692	12,578	12,185	11,233	10,944
Orchard Gate Return per hectare (average)	**123,041**	107,142	96,033	79,361	68,868	60,758	57,369	49,385
Number of producers	**2,813**	2,792	2,756	2,405	2,435	2,156	2,540	2,350
Average number of trays supplied per producer	**56,754**	53,057	55,899	51,739	59,906	47,752	37,670	36,813
Number of Orchards Registered								
0 – 2 hectares	**734**	738	717	774	791	807	834	802
2 – 5 hectares	**1,544**	1,540	1,575	1,509	1,508	1,499	1,428	1,458
5 – 10 hectares	**720**	693	702	607	589	568	515	487
Over 10 hectares	**214**	211	207	165	161	147	128	126
Total (KPINS)	**3,222**	3,182	3,201	3,055	3,049	3,021	2,905	2,873

	2020/21	2019/20	Variance
Zespri global kiwifruit sales	3.583 billion	3.140 billion	14%
Export earnings (New Zealand grown)	2.599 billion	2.272 billion	14%
New Zealand-grown fruit and service payments	2.253.2 million	1.962.5 million	15%
New Zealand-grown Orchard Gate Return (OGR) per hectare	$123,041 (average)	$107,142 (average)	15%
- Green	$76,722	$67,295	14%
- Organic Green	$66,453	$63,734	4%
- SunGold[1]	$177,846	$161,660	10%
- Organic SunGold[1]	$158,599	N/A	N/A
Zespri global volume (trays sold)	181.5 million	164.4 million	10%
New Zealand-grown	158.0 million	145.3 million	9%
Non-New Zealand-grown	23.5 million	19.1 million	23%

Key figures from Zespri's Annual Results 2020-21

[1] 2019/20 comparative for SunGold reflects the combined pool of Zespri SunGold and Organic SunGold kiwifruit. These varieties have been split into separate pools for the 2020/21 year, as reflected above.

NEW ZEALAND INDUSTRY PERFORMANCE

Regional Production Analysis - NZ Grown Kiwifruit - Trays Supplied to Zespri - FOBS

	2020/21		2019/20		2018/19		2017/18	
Tray Equivalents (TEs) supplied to Zespri (FOBS)	**Producing Hectares**	**TE Supplied per ha**	Producing Hectares	TE Supplied per ha	Producing Hectares	TE Supplied per ha	Producing hectares	TE Supplied Per ha
Zespri Green Kiwifruit								
Northland	**81**	**8,829**	100	6,835	106	8,498	109	5,779
Auckland	**243**	**8,030**	256	7,175	262	9,974	273	7,719
Bay of Plenty								
Katikati	**859**	**8,011**	830	8,960	859	9,882	940	7,678
Ōpōtiki	**436**	**10,735**	444	10,834	455	11,315	457	8,917
Tauranga	**996**	**10,625**	1,066	9,773	1,087	12,014	1,086	9,193
Te Puke	**3,079**	**11,551**	3,190	11,058	3,292	12,380	3,419	9,641
Waihi	**106**	**7,608**	132	7,771	138	9,858	100	6,569
Whakatāne	**309**	**7,434**	331	8,369	366	10,541	402	7,728
Waikato	**202**	**8,297**	204	9,113	203	9,076	200	8,339
Poverty Bay	**40**	**6,054**	44	6,801	52	7,745	54	8,366
Hawke's Bay	**41**	**6,005**	41	6,916	45	7,358	43	6,620
Lower North Island	**69**	**8,623**	69	9,062	70	9,291	70	8,696
South Island	**197**	**6,226**	208	6,519	223	7,258	229	5,663
Total producing hectares	**6,659**		6,915		7,158		7,382	
Average TE supplied per hectare		**10,133**		9,932		11,320		8,812

	2020/21		2019/20		2018/19		2017/18	
Tray Equivalents (TEs) supplied to Zespri (FOBS)	**Producing Hectares**	**TE Supplied per ha**	Producing Hectares	TE Supplied per ha	Producing hectares	TE Supplied Per ha	Producing hectares	2016/17
Zespri Organic Green Kiwifruit								
Northland	**-**	**-**	-	-	-	-	-	-
Auckland	**1**	**5,118**	1	2,626	1	5,364	1	2,614
Bay of Plenty								
Katikati	**29**	**6,427**	30	6,095	30	9,061	30	6,593
Ōpōtiki	**22**	**7,400**	21	7,092	21	7,493	22	5,786
Tauranga	**177**	**7,333**	174	6,599	182	8,604	203	6,033
Te Puke	**35**	**8,276**	37	7,924	38	8,775	42	6,979
Waihi	**22**	**3,961**	22	5,077	22	6,589	19	3,964
Whakatāne	**4**	**2,742**	4	3,178	4	4,594	4	4,197
Waikato	**147**	**4,875**	147	6,047	148	6,885	151	5,310
Poverty Bay	**-**	**-**	0	2,728	1	4,042	1	3,676
Hawke's Bay	**-**	**-**	-	-	-	-	-	-
Lower North Island	**2**	**3,330**	2	3,763	2	4,439	2	5,552
South Island	**-**	**-**	-	-	-	-	-	-
Total producing hectares	**439**		437		448		475	
Average TE supplied per hectare		**6,296**		6,386		7,863		8,812

	2020/21		2019/20		2018/19		2017/18	
Tray Equivalents (TEs) supplied to Zespri (FOBS)	**Producing Hectares**	**TE Supplied per ha**	Producing Hectares	TE Supplied per ha	Producing hectares	TE Supplied Per ha	Producing hectares	TE supplied per ha
Zespri SunGold Kiwifruit (Gold 3)								
Northland	**386**	**13,251**	368	11,0738	356	12,327	319	8,044
Auckland	**234**	**14,312**	227	12,865	214	12,143	206	10,701
Bay of Plenty								
Katikati	**597**	**13,285**	537	13,421	497	13,531	525	11,299
Ōpōtiki	**571**	**13,901**	543	14,132	520	13,827	506	12,172
Tauranga	**517**	**14,580**	500	13,133	476	14,100	437	12,320
Te Puke	**2,402**	**15,252**	2,085	14,228	1,811	13,744	1,655	12,390
Waihi	**97**	**12,256**	105	11,887	92	12,811	53	9,168
Whakatāne	**341**	**13,405**	274	12,074	240	11,931	211	13,211
Waikato	**185**	**12,773**	197	11,239	192	10,712	183	7,937
Poverty Bay	**311**	**10,727**	267	12,321	244	11,937	208	9,740
Hawke's Bay	**165**	**11,034**	156	12,559	152	10,840	149	8,263
Lower North Island	**1**	**10,096**	1	11,093	2	5,955	2	7,799
South Island	**241**	**15,189**	224	14,897	200	14,135	176	8,693
Total producing hectares	**6,047**		5,483		4,996		4,630	
Average TE supplied per hectare		**14,130**		13,443		13,216		11,292

	2020/21		2019/20		2018/19		2017/18	
Tray Equivalents (TEs) supplied to Zespri (FOBS)	**Producing Hectares**	**TE Supplied per ha**	Producing Hectares	TE Supplied per ha	Producing hectares	TE Supplied Per ha	Producing hectares	2016/17
Zespri Organic SunGold Kiwifruit (Gold 3)								
Northland	**9**	**7,579**	-	-	-	-	-	-
Auckland	**4**	**8,687**	-	-	-	-	-	-
Bay of Plenty								
Katikati	**2**	**7,868**	-	-	-	-	-	-
Ōpōtiki	**11**	**7,939**	-	-	-	-	-	-
Tauranga	**30**	**10,618**	-	-	-	-	-	-
Te Puke	**52**	**12,350**	-	-	-	-	-	-
Waihi	**13**	**9,307**	-	-	-	-	-	-
Whakatāne	**-**	**-**	-	-	-	-	-	-
Waikato	**18**	**8,263**	-	-	-	-	-	-
Poverty Bay	**3**	**-**	-	-	-	-	-	-
Hawke's Bay	**-**	**-**	-	-	-	-	-	-
Lower North Island	**2**	**4,871**	-	-	-	-	-	-
South Island	**-**	**-**	-	-	-	-	-	-
Total producing hectares	**142**		-		-		-	
Average TE supplied per hectare		**10,253**		-		-		-

	2020/21		2019/20		2018/19		2017/18	
Tray Equivalents (TEs) supplied to Zespri (FOBS)	**Producing Hectares**	**TE Supplied per ha**	Producing Hectares	TE Supplied per ha	Producing hectares	TE Supplied Per ha	Producing hectares	TE supplied per ha
Zespri Sweet Green Kiwifruit (Green14)								
Northland	**-**	**-**	-	-	1	5,809	1	3,401
Auckland	**12**	**3,088**	14	2,894	18	4,196	14	5,238
Bay of Plenty								
Katikati	**8**	**4,307**	9	4,718	8	5,871	11	7,377
Ōpōtiki	**5**	**5,687**	5	7,353	8	8,003	12	7,790
Tauranga	**1**	**5,771**	1	7,380	4	7,254	6	5,845
Te Puke	**9**	**8,719**	17	7,778	59	6,944	80	7,711
Waihi	**-**	**-**	-	-	-	-	-	-
Whakatāne	**5**	**5,844**	7	5,674	17	6,863	18	7,550
Waikato	**-**	**-**	8	6,248	11	5,032	15	5,428
Poverty Bay	**-**	**-**	-	-	3	5,298	4	6,985
Hawke's Bay	**7**	**7,831**	7	5,920	8	3,682	8	4,415
Lower North Island	**1**	**2,471**	2	3,181	4	2,602	4	6,486
South Island	**-**	**-**	-	2,789	2	4,013	2	2,789
Total producing hectares	**48**	**-**	70	-	145		175	
Average TE supplied per hectare		**5,608**		5668		6,150		6,925

Production area and trays supplied of kiwifruit varieties by region over the past four seasons.

GLOSSARY

Zespri Variety names:

Business Name	Abbreviation	EDI variety code	Zespri brand name	PVR denomination (legal name)
Hayward	HW	HW	Green	Hayward
Gold 3	G3	GA	SunGold	ZESY002
Hort16A	16A	GK	Zespri Gold	HORT16A
Red 19	R19	RS	Ruby Red	ZES008
Green 14	G14	HE	Sweet Green	ZESH004

Terms and Definitions

Term	Definition
5-Year Outlook	Annual document outlining Zespri's strategies for each category for the next 3 years and beyond.
12-month supply	Sourcing kiwifruit globally, for supply to Zespri customers and consumers year-round.
Allophanic Soil	Crumbly, free draining soil with limited natural fertility.
Apical dominance	The growing shoot tip inhibits the growth of lateral or axillary buds.
Bio-stimulants	Include diverse formulations of compounds, substances and micro-organisms that are applied to plants or soils to improve crop vigour, yields, quality and tolerance to stresses.
Black seeds	The number of mature black seeds in a fruit. It is used as a measure of maturity.
Botrytis	A pathogenic fungus that causes grey mould and storage diseases in kiwifruit.
Brix	Percentage of sugar by weight (grams per 100mL water) in juice of kiwifruit.
CA	Controlled Atmosphere – regulating the O_2 and CO_2 levels, as well as temperature and humidity of sealed storage facilities; slows down ripening (effectively putting fruit into hibernation) and improves firmness of stored fruit.
Checkpoint	Process/check undertaken at wharf – fruit is electronically scanned as it is loaded onto the vessel.
Chlorosis	Condition in which leaves produce insufficient chlorophyll so may be pale, yellow or yellow-white. Often a symptom of phytotoxicity.
Collaborative Marketer	KNZ approved kiwifruit exporter from NZ (other than Zespri).
CPS	Crop Protection Standard – Set of rules for agrichemical use, determined by Zespri, which ensures fruit meets legal requirements of export markets as well as customer and consumer requirements for food safety and sustainability.
Cultivar	New variety produced by selective breeding.
Dioecious	Having separate male and female plants.
DM	Dry Matter – calculated as the ratio of dry to fresh weight. DM = Dry weight ÷ fresh weight. Dry weight constituents include carbohydrates, proteins, acids and minerals.

EDI	Electronic Data Interface – supply chain information transferred from Postharvest operators to Zespri.
Exudates	Fluid leaking from Psa infected vines from cankers or wounds; may be red/orange or white, may appear as dried stains rather than fresh.
FOBS	Free On Board Ship – a trade term, Zespri takes ownership of the fruit when it is loaded on a vessel.
Fruit and Service Payments	Payments made by Zespri for supply of fruit. Fruit payments (submit and progress payments) and service payments are in place to incentivise the supply of kiwifruit with desired characteristics to gain the best sales return.
Global GAP	Global Produce Working Group code for Good Agricultural Practice – set of criteria under which fruit is produced, audited annually. Growers must have Global GAP certification for Zespri to accept their fruit into inventory.
Gold3	Gold cultivar commercialised by Zespri in 2010, otherwise known as SunGold. Replaced ZespriGold (Hort16A) that was susceptible to Psa. Has PVR protection; growers must purchase license to be able to grow it.
Gold9	Gold cultivar commercialised by Zespri in 2010, otherwise known as ZespriCharm. It was decommercialised due to faults in its storage ability and physical appearance.
Green14	Green cultivar commercialised by Zespri in 2010, otherwise known as SweetGreen. Sweeter fruit than the traditional green Hayward. Has PVR protection; growers must purchase license to be able to grow it.
Hayward	Green cultivar, predominant variety since the 1960s.
Hort16A	Gold cultivar commercialised by Zespri in 2000, otherwise known as ZespriGold. Hort16A was highly susceptible to Psa and was replaced by Gold3.
IAC	Industry Advisory Council – made up of representatives of Zespri, Growers and Supply Entities; manage issues relating to the supply contract - the treatment of and payment of fruit and matters with material financial implications for growers.
ISG	Industry Supply Group – made up of representatives Zespri, Growers and Supply Entities; manage decisions relating to the supply chain process - quality assurance and rules around labelling, packaging and the export of kiwifruit.
IT	International Tray – single layer packaging tray for fruit (size 18-36), 3.6kg.
KISP	Kiwifruit Industry Strategy Project – long term plan developed by industry representatives to achieve market, strategic and financial goals for the benefit of NZ Growers.
Kiwistart	Period early in Harvest (ISO weeks 11/12 to 18/19, although dates vary with variety and can change depending on maturity) for which a premium is paid for fruit submitted, as an incentive to ensure supply of kiwifruit early in the season.
Kiwigreen	Zespri's Integrated Pest Management programme for pest and disease control, uses environmentally responsible production methods to ensure minimal/nil chemical residues.
KNZ	Kiwifruit New Zealand – industry regulator who give Zespri the mandate to be the vehicle for the SPE. Also allows other exporters to trade NZ grown kiwifruit outside of Australasia via collaborative marketing agreements.
KPIN	Kiwifruit Property Identification Number – a unique ID that every orchard must have. Allows traceability of fruit.
KVH	Kiwifruit Vine Health – independent industry body responsible for biosecurity.
M2	Modular Double – packaging tray with 2 layers of fruit (Green and Gold).
MB	Modular Bulk – loose fill packaging for fruit, 10kg net fruit weight (Green).

ML	Modular Loose – loose fill packing for fruit, 6.8kg net fruit weight (Gold).
MRL	Maximum Residue Level – every agricultural compound used in food production has a maximum residue level set. Each country determines its own MRLs.
MTP	Maximum Taste Payment – Determined by Zespri each year for each variety (amount per tray). Growers receive a taste payment - a portion of the MTP per tray depending on their TZG and size profile.
MTS	Minimum Taste Standard – Zespri initiative used to optimise taste, sets minimum DM levels for crops to be exported.
NSS	Non-Standard Supply – fruit that does not meet Zespri's Class 1 standard i.e., small or below MTS. Sold on local market, processed or used for stock food.
OGR	Orchard Gate Return – Net Income a grower receives (Income from Zespri less Cost of Postharvest).
Osmoregulation	Process of maintaining internal balance between water and dissolved materials (electrolytes) regardless of environmental conditions.
Phenology	Study of the timing of biological events in the lifecycle of plants and animals such as bud break, flowering, maturity, dormancy.
Phloem	Transport tissue in vascular plants; conducts sugars and other metabolic products downwards from the leaves.
Phytosanitary	Verification (in terms of inspection or provision of a certificate) that plants or plant products are free from quarantine pests or diseases.
Phytotoxicity	Toxic effect by a compound on plant growth; range from delayed growth, misshapen leaves or fruit, discoloured or dead spots on leaves, to death of the plant.
PLU	Price Look Up – identification number affixed to produce (by fruit sticker) to make check-out and inventory control easier.
Psa	*Pseudomonas syringae pv. actinidiae* – bacterial disease that affects kiwifruit vines.
Psa-V	Indicates the virulent strain of the bacteria that exists in New Zealand.
Postharvest	Packhouse and cool-store operations.
Sclerotinia	A pathogenic fungus that causes fruit loss from diseased fruitlets, fruit scarring and field rot in kiwifruit.
Size profile	Fruit range in size from size 16 to size 46. Size is relative to weight, so fruit sizes correspond to the number of fruit that can fit into a 3.6kg tray (IT). Size profile is the number of trays of each size grade in a crop.
SPE	Single Point of Entry – use of one exporter rather than multiple exporters e.g., Zespri holds the SPE for the NZ Kiwifruit industry.
TE	Tray Equivalent – unit of volume measurement based on a single layer tray (IT).
TZG	Taste Zespri Grade – Figure calculated from the dry matter of fruit at each size profile in the crop. Used for calculating the taste payment a grower receives.
Xylem	Transport tissue in vascular plants; conducts water from the roots to the shoots and leaves.
Zespri	Zespri International Ltd (ZIL) – Limited liability company owned by current and past kiwifruit growers; the world's largest marketer of Kiwifruit.
ZGL	Zespri Group Limited – Parent company of which ZIL is the operating subsidiary.
ZGS	Zespri Global Supply – program under which Zespri grows fruit in Italy, France, Japan, South Korea and Australia to ensure 12-month supply to retailers.

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