



2018
Kiwifruit
Book

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

Kiwifruit Quick Facts



#1



THERE ARE APPROXIMATELY
2,600
KIWIFRUIT GROWERS IN
NEW ZEALAND

#2



KIWIFRUIT REPRESENTS
33% OF THE TOTAL
HORTICULTURE EXPORT REVENUE

#3



THE WORLD'S 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
CHINA, JAPAN, SPAIN, TAIWAN,
GERMANY AND SOUTH KOREA

#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



NEW ZEALAND KIWIFRUIT
INDUSTRY FORECAST TO REACH
\$4 BILLION
REVENUE BY 2027



FOREWORD

Welcome to the fourth 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 what is thought to be relevant in 2018, from orchard practices and the industry's structure, through to international marketing and the exportation of kiwifruit.

The development of this kiwifruit book started in 2014, through a query made by Rick Jochem, an Ag/Hort teacher from Palmerston North Boys High School, asking if New Zealand Kiwifruit Growers Incorporated (NZKGI) would consider supporting the development of a kiwifruit workbook for use in secondary schools. Rick expressed concern at the limited availability of kiwifruit industry information available online. NZKGI agreed to support Rick and utilised funding received from a grower through the Acorn Foundation,

together with a number of industry resources, to pull together relevant information for the first edition of the book.

Four years later, the 2018 edition of The Kiwifruit Book has undergone a significant refresh and restructure to improve the book's usability and ensure it contains up-to-date, relevant information. Part of this restructure was to split all topics into subject areas such as science, technology, business and technical on-orchard development and management. A careers chapter has also been included to ensure that readers understand the vast choice of career options available within the industry.

We 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.

CONTRIBUTORS

NZKGI would like to sincerely thank all those that have invested their time into the development of this kiwifruit book. The information you have provided in this research has been of huge value and could not have taken place without your support. Those who have been instrumental to the 2018 Kiwifruit Book include:

Acorn Foundation, Bay of Plenty

Anton Baker, Zespri Global Marketing

Ben Luke, Zespri Orchard Productivity Centre (OPC)

Beth Kyd, Zespri Orchard Productivity Centre (OPC)

David Armour, Zespri Innovation

Jamie Lunam, Jenkins Freshpac Systems

Jamie Troughton, New Zealand Kiwifruit Journal

Jayson Bengel, The Agribusiness Group

Kate Longman, (Formerly NZKGI)

Liarna Fraser, Kiwifruit Grower

Lisa Gibbison, Kiwifruit Vine Health (KVH)

Lynda McCalman, New Zealand Kiwifruit Growers Incorporated (NZKGI)

Mel Auld, Zespri Global Marketing

Mike Murphy, New Zealand Kiwifruit Growers Incorporated (NZKGI)

Renee Fritchley, New Zealand Kiwifruit Growers Incorporated (NZKGI)

Rick Jochem, Palmerston North Boys High School

Robin Dillimore, Zespri Shipping

Shane Max, Zespri Orchard Productivity Centre (OPC)

Shaun Gardner, Zespri Logistics and Supply Chain

Tim Mayston, Mayston Partners Ltd

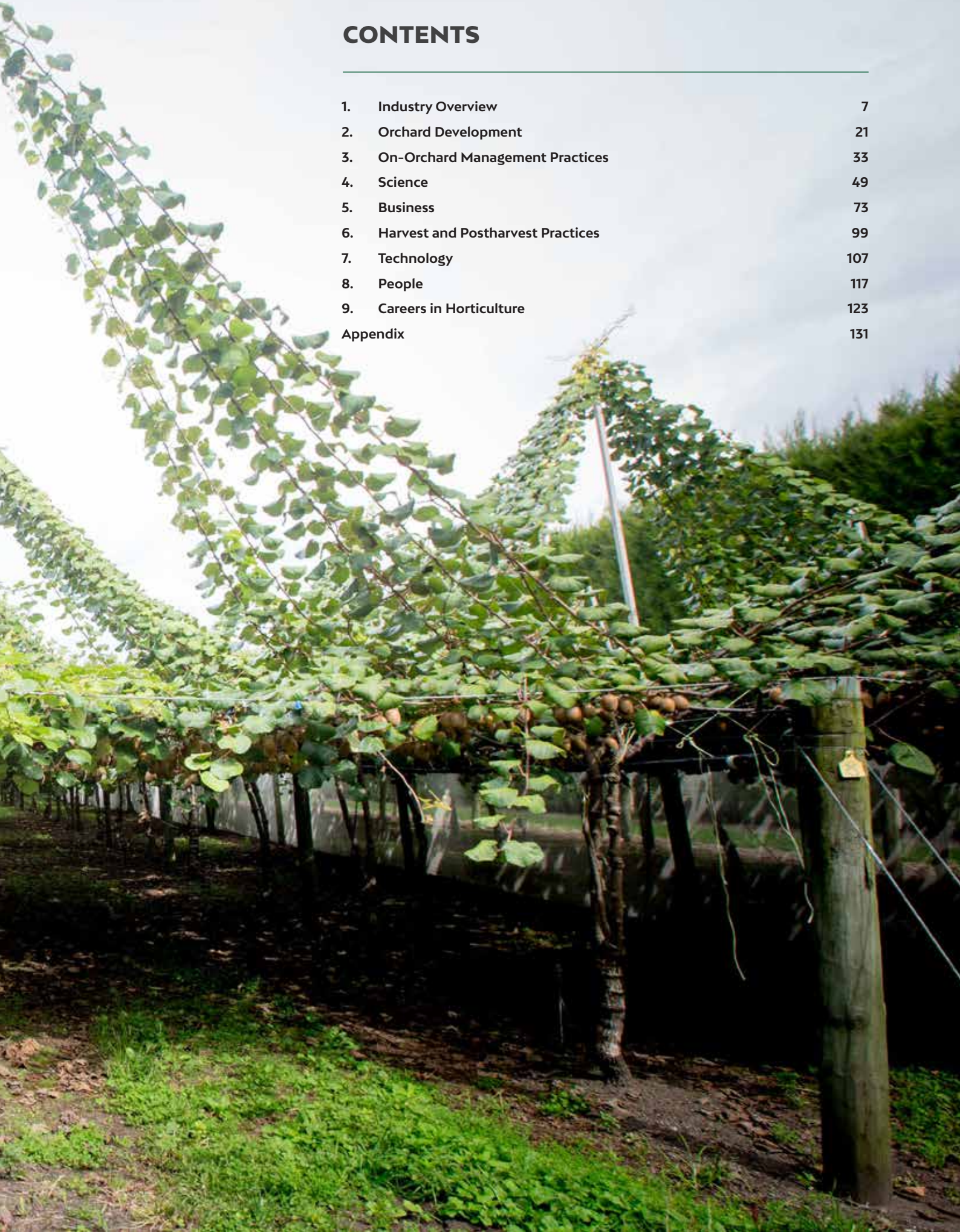
Toby Potter, EastPack

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NZKGI on 0800 232 505





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 2017/18 period.

THE SECTION IS DIVIDED AS FOLLOWS

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1.1 INDUSTRY OVERVIEW

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 1927, New Zealander Hayward Wright bred a cultivar of kiwifruit known as 'Hayward'. By the 1960's, 'Hayward' became the standard cultivar of exported kiwifruit around the world and now makes up 90% of the world production of kiwifruit.



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 licence exporters, such as Turners and Growers, the New Zealand Fruitgrowers' Federation and Auckland Export and at its peak had up to seven exporters licenced.

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



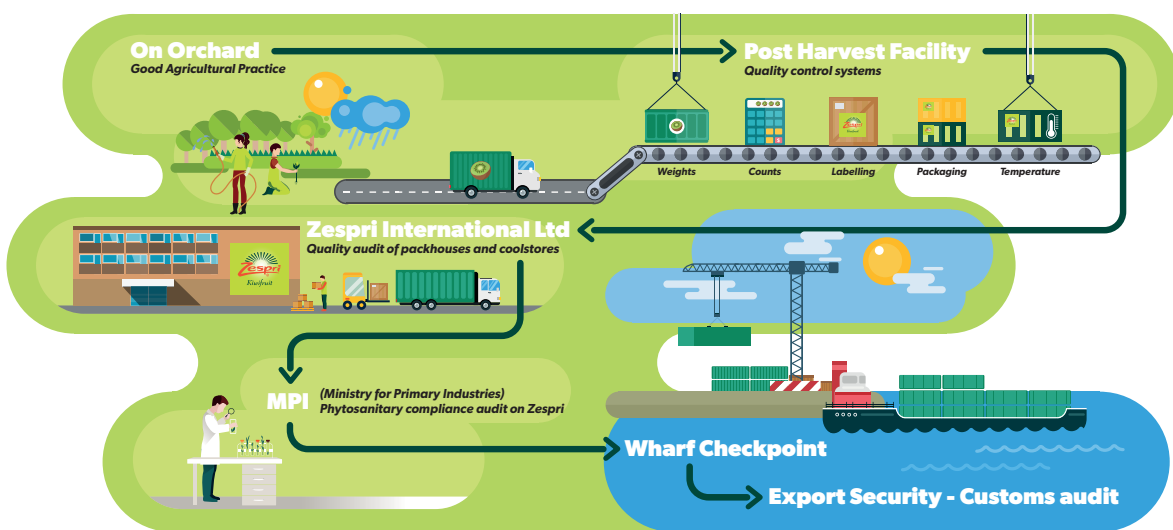
1.3 1980 - 1990

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.



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).

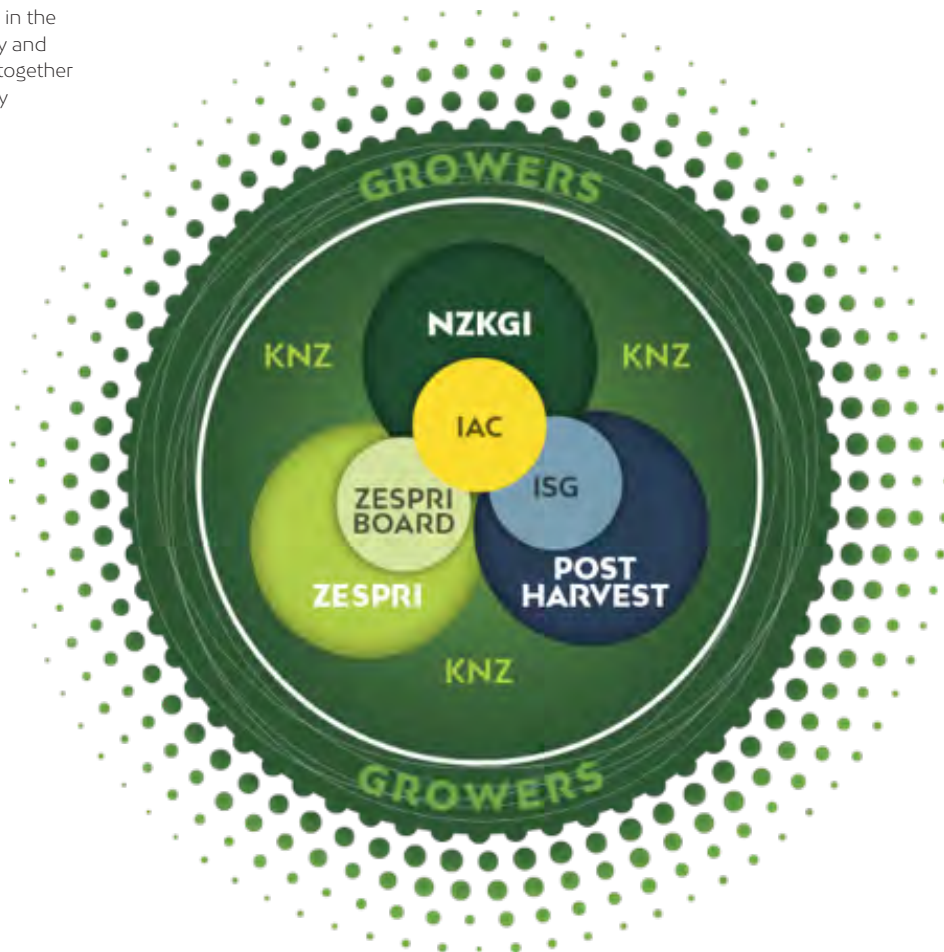
The regulations enabled Zespri to make changes to its constitution to allow for greater alignment between growers and shareholders. The regulations also expanded the definition of core business which is expected to provide stability to Zespri as the industry grows, maximizing the wealth of New Zealand kiwifruit growers. The regulations have made significant changes to the governance and funding of KNZ and while growers no longer have a majority on the KNZ Board, independent expertise has been 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 began in September 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 past and present New Zealand kiwifruit growers, which in addition to its role as the single desk marketer also provides logistics services and research and development management for the kiwifruit industry.



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. A key research and development objective for KVH is to jointly lead (with Zespri), a world class research and development programme that continually seeks to identify ways to best manage all biosecurity risks to New Zealand's kiwifruit industry.



New Zealand Kiwifruit Growers Incorporated (NZKGI)

NZKGI was formed following the downturn in the kiwifruit industry in 1994 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, with a bottom line aim to increase growers' returns.



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 Forum

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 majority of the New Zealand kiwifruit sector is focussed on the export of fresh fruit. 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). KNZ is the kiwifruit industry's regulator and 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 aims to specifically cater to the financial, tax and government related aspects of the kiwifruit industry. 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.

The Industry Supply Group (ISG)

The Industry Supply Group manages decisions relating to the 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.

Zespri Board

The Zespri Board provides strategic direction for the company and ensure it meets all regulatory requirements.

1.7.1 Levy-Funded Organisations

KVH

KVH is funded through two levies, a National Pest Management levy for the management of Psa which is set at 0.6c per tray and a levy for biosecurity readiness and response activities which is set at 1 and 4/10th cents per tray for all varieties. 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 1c/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 2,600 kiwifruit growers in New Zealand and around 12,692 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 China. New Zealand grown Zespri kiwifruit generated global sales revenue of \$2.129 billion in the 2017/18 season and sold 123.2 million trays (3.55kg = 1 tray).



The return made by New Zealand kiwifruit export revenue in the 2017 year is significant in comparison to other fruit and vegetables. Kiwifruit was \$1.7 billion whilst total horticultural export revenue was \$5.1 billion. Kiwifruit represents 33% 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 increased by over 50% during the last decade, 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 2017/2018 year	
Northland	440
Auckland	494
BOP	10,238
Waikato	549
Poverty Bay	267
Hawkes Bay	202
Lower North Island	78
South Island	424

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





CHAPTER TWO ORCHARD DEVELOPMENT

There are around 13,500 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 this time, particularly in the last 10 years. This chapter identifies important aspects of orchard development.

THE SECTION IS DIVIDED AS FOLLOWS

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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, then a year later the variety of kiwifruit to be grown
- Support structures, initially post and wire then pergola (usually steel agbeam)
- 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 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)



2.3 SHELTER

It is important to have shelter established before kiwifruit vines are planted. Good shelter raises orchard yields through improved growth, better pollination and allows for export quality fruit. Crops produced in well-sheltered blocks can also have significantly less rejects due to wind-rub, especially skin sensitive Gold varieties. In reducing damage to kiwifruit vines, the likelihood of Psa-V infection is also reduced. Apart from reducing wind damage, good shelter reduces wind speeds and can thus increase orchard temperatures. Reducing wind speeds reduces evapotranspiration, decreasing how much water the vines require in windier seasons. Cold temperatures during flowering/fruit set can reduce bee activity, restrict the growth of pollen tubes, and prolong flowering and slow fruitlet growth, all impacting final fruit size.

Types of shelter

Natural shelter (e.g. tree shelterbelts) is used extensively in New Zealand. Natural shelter is cheap but takes time to establish. Kiwifruit vines need the most protection when the vines are developing and if natural shelter is being grown at the same time as young kiwifruit vines, it will not provide adequate protection. 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, rather than waiting for natural shelter to establish.

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. Overhead shelters hang above kiwifruit vines. Overhead shelters have an expensive outlay cost, but the financial rewards can be significant. The benefits include:

- reducing the impact of a hail event to nothing 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;
- and improved pest control.

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)



Growers have reported improved pest control with the elimination of susceptible shelter species that can harbour pests such as leafroller, scale and passion vine hopper. There are also reports of improved cicada control in using overhead shelter as emerging adults do not like the enclosed canopy and immediately fly to one end and attempt to exit. 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.

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)





2.4 IRRIGATION

Young developing vines require constant watering to help develop healthy leaf growth and root systems. Irrigation requirements are variable throughout New Zealand. Soil type is a significant factor in determining how much and how often a block of kiwifruit is watered. Improvement 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 be watered more frequently. 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 seasons yield.

Excessive irrigation, particularly in clay soils, can also be detrimental to the productivity of kiwifruit vines. If the roots of the kiwifruit vine remain under water for too long, then they effectively drown. This is termed 'wet feet'. Excessive wet feet can reduce fruit quality and yield due to the reduced root system. 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 fruits dry matter. Growers are paid using both measures. Irrigation can also be used for frost protection.

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



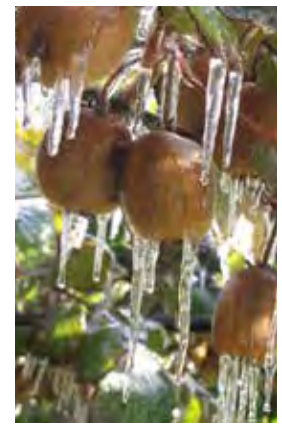
2.5 FROST PROTECTION

Nearly all the horticulturally significant frosts in New Zealand are of the radiation type. Radiation frosts occur on nights with clear skies and little or no wind. As heat is radiated away from the surface of vegetation (or other objects) the surface cools and draws heat from the plant material and the surrounding air. If suitable conditions persist, the temperature of the plant material falls to a point where irreversible damage occurs to the plant tissue.

Frost damaged fruit are not edible or saleable and frost damage to vines can negatively impact productivity of kiwifruit vines the following season.

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

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



2.5.1 Methods of Frost Protection

A wide range of methods are presently used to protect horticultural crops against frost damage and can be loosely grouped into four main classes; directly heating the vines, mixing the air to disturb the temperature inversion, the use of a radiation barrier and the use of cold air drainage.

Heating

Actively heating the area may employ specially designed burners known as 'frost pots'. Frost pots are fuelled by oil, natural gas, LPG or by special solid fuel blocks or candles made from wax, compressed wood waste or other similar materials.

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.

Right:
"Frost pot" burner used to
heat orchard area

Far right:
Sprinklers used for frost
protection
(Shane Max, Zespri OPC)



Mixing

A wind machine is essentially a large fan (with a horizontal axis) which rotates around the top of a 10 or so metre tower, located in the centre of the area to be protected. The 'jet' of air produced by the fan entrains the warm air from above the orchard and mixes it into the colder air closer to the ground.

Flying a heavily laden helicopter at relatively slow speed across the orchard area can also effectively mix the air and provide frost protection but has the advantage over wind machines of being able to concentrate on selected areas if required, and to fly at greater elevations to provide added mixing capability.

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, fog or some other radiation barrier.

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 an open environment, the lowest point is often at lakes, ponds or river beds. However, in kiwifruit orchards, natural or artificial shelter can trap cold air so that it pools in kiwifruit blocks 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 the shelterbelt, or repositioning shelter to allow for cold air to escape.



2.6 ROOTSTOCKS AND GRAFTING

Grafting is the joining of two plants to create desirable characteristics expressed in one plant. Female kiwifruit vines are generally not one type of kiwifruit cultivar. A female kiwifruit cultivar is grafted on top of another type of female kiwifruit cultivar. The plant on the top is called a scion and the plant on the bottom is called a rootstock. The scion is chosen for the fruit it produces (e.g. Gold, Gold3, Gold9, Green14, Green). The rootstock is chosen for desirable characteristics such as tolerance to their roots being wet for long periods (known as 'wet feet'). The rootstock can also impart its characteristics on to the scion, such as reduced vigour. Reduced vigour aids in reduced pruning costs but it also takes longer for vines to establish.

There are a number of rootstocks used and the most common is 'Bruno'. Bruno has been used for many years due to its strong vigour and Psa tolerance. Less common rootstocks include: Hayward; Kaimai; Hort16A; and Bounty. Hayward is less vigorous and can produce fruit that is more variable than Bruno when it is used as a rootstock. Both Kaimai and Hort16A are highly susceptible to Psa. Bounty, a

more recently bred rootstock, has Psa tolerance and appears to tolerate dry conditions as well as wet feet.

Bounty is referred to as a clonal rootstock; with clonal rootstocks, every individual plant is genetically identical, therefore every Bounty rootstock on an orchard will deliver exactly the same attributes to the scion. The other rootstocks, including the common Bruno, were grown from seedlings. This means that every Bruno rootstock is genetically different, so there is potential for the different Bruno genotypes within an orchard to create variation in vine growth and fruit quality.

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.

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



There has been extensive re-grafting in the kiwifruit industry post Psa to remove the most susceptible cultivars and replace them with the most tolerant ones. There are a number of places on the vine that can be grafted, they include: notch grafting (side graft); stump grafting; and sucker/rootstock grafting. When the grower has decided where to graft, the type of graft is chosen. These include: kerf (chainsaw) grafting; cleft grafting; and whip and tongue grafting.

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 (sap flow can also be termed bleeding where there is exudation from cuts. Bleeding is less likely when plants are dormant). 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.

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, there may be high rate of grafting failure in winter, or there may be high levels of Psa infection. 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 insuring graft success. New shoot growth is vulnerable to damage from birds, leafrollers, bronze beetle, slugs and snails, as well as diseases such as Psa-V. 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. When using insecticides, wet-able powder sprays are least likely to damage new shoots and emulsifiable concentrate formulations are the most likely to cause damage. 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=4lkpc7pv41g
www.youtube.com/watch?v=QV4AICjPUIE

2.7 STRINGING

Many orchardists, during the conversion or establishment stages of orchard development, employ a management practice called stringing. This is when new leaders and canes are grown up strings. This causes lots of rapid vegetative growth that 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. Canes growing up strings 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 step 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.”



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

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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 metres 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. The kiwifruit are 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, signalling 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, winter chilling with an ideal soil pH between 5 and 6.8. To be productive, commercial crops require significant management. Vine training, pruning, pollination, shelter from the wind and pest and disease control among other things all have a significant impact on the profitability and productivity of the crop. These management practices impact the size and the dry matter of fruit and the market acceptance of the fruit.

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 metres in length during the growing process).”



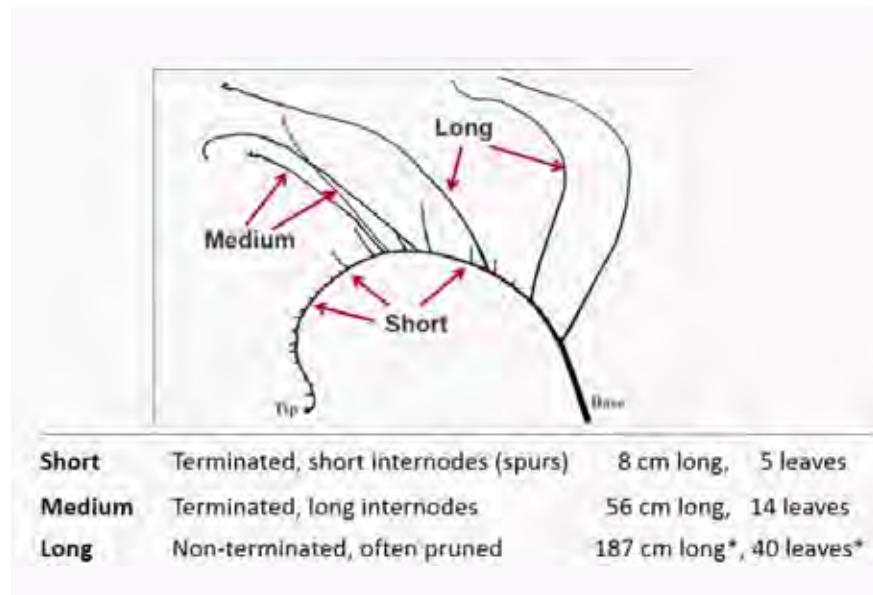
Above:
On-orchard kiwifruit
production steps and key
management actions

3.2 VINE MANAGEMENT – PRUNING

Pruning is one of the most important aspects of vine management and plays a major role in getting a consistent, quality yield each season. Successful management 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 penetration of light throughout the vines to minimise the conditions which favour fungal disease such as Botrytis.

Open vines also provide adequate light needed to ripen the fruit and mature the fruiting canes for the following season. It is only under conditions of reasonable light penetration that new fruitful shoots will originate from the desired points on or close to the main leader. Good light levels are vital for dry matter and sugar level production in the fruit, it 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:
Shoot types



3.2.1 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. The aim is to set up bays with optimal high-quality winter bud numbers on canes that are evenly spaced throughout the canopy.

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). The aim is to fill the canopy so there is an even cane spacing and

no gaps. 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.



Right:
An even spread of high quality winter buds
(Shane Max, Zespri OPC)

3.2.2 Summer Pruning

Summer pruning involves removing excess vegetation from 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 canopy, thereby allowing resources to be redirected to the fruit; and to allow good spray coverage. The removal of excess growth also helps to prevent tangles and aids the development of next year's canopy which should in turn help to reduce work load and costs of winter pruning.

Pruning male vines during spring and 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-V, keeping a compact vine structure over summer also allows for better spray coverage.

Why are light levels important? Good light levels will keep all the leaves in the canopy functioning which will: enhance dry matter and sugar levels in the fruit; improve taste; maximise fruit size; and enhance the storage life of the fruit. An open canopy will also improve airflow and spray penetration, reducing the risk of pests and disease.

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:

- To tip 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.
- Vigorous excess canes will compete with fruit growth and increase shading.
- 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 often the most fruitful.
- 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 not optimal for vine structure and growth.

3.2.3 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?

Is to prune 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. It helps manage excessive vine vigour and maintain good light levels within the fruiting canopy. If this technique is done correctly, the vines aren't 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. However, this increases the risk of Psa infection due to creating a soft tissue wound. Studies have shown that it doesn't have a negative impact on fruit quality but it is also unlikely to improve productivity or fruit quality.

What is Tip Squeezing?

Tip squeezing involves damaging the growing tip of actively growing shoots that would otherwise not self-terminate in spring and early summer. Tip squeezing prevents the shoot extending past a manageable length. 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, maintaining suppression of secondary growth while disabling the extension of the shoot. 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.

“ 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. ”

3.3 BUDBREAK

Growers have a variety of mechanisms to get sufficient yields of high quality fruit, these include:

- Selection of high quality replacement cane in spring and removal of poor quality growth.
- 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.
- Pruning – Removing unwanted vegetative growth early.
- Budbreak sprays.
- Constant use of best practice management throughout the season.



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 pistillate and staminate occur on separate plants (male and female reproductive organs are on different plants). This makes pollination and the mix of male and female plants vitally important to achieving economic success. Successful pollination requires a sufficient number of male and female flowers which in turn requires a sufficient number of buds to have broken into blossom.

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. For example, the Zespri forecast return from August 2014 predicted that the value of increasing fruit weight by 1 gram could equate to the following financial returns:

- Green \$800 per hectare
- Gold3 \$1,700 per hectare
- Green14 \$900 per hectare

However, achieving full pollination of kiwifruit flowers is difficult because:

- Pollen must be moved large distances as male and female flowers are borne on separate vines.
- Fruit size and the value of the crop is in part determined by the number of seeds the fruit contain which is dependent on the level of pollination.
- Female flowers need to receive thousands of pollen grains for full

pollination (1,000 black seeds), unlike flowers of other fruit crops that only require a few pollen grains.

- Green needs 12,000 pollen grains to achieve full pollination of 1,200-1,500 seeds.
- Gold3 needs 6,000 pollen grains to achieve full pollination of 600-800 seeds.
- Green14 needs 6,000 pollen grains to achieve full pollination of 1,400 seeds.
- Kiwifruit vines have relatively few flowers and require high levels of fruit set (>80%) 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.
- The vines flower late in the spring and consequently can have strong competition for insect visitors from other plants flowering at the same time.
- Kiwifruit vines were introduced into New Zealand from China, so they are without the 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.

For these reasons the pollination of kiwifruit needs to be managed to a much greater extent than most other crops. This has resulted in the development of a pollination system for kiwifruit that is more sophisticated than that is used for almost any other crop in the world. The costs associated with pollination are also greater than for almost all other crops in New Zealand. Flowering and pollination occurs in spring, but the timing varies by region, altitude and variety. Most kiwifruit orchards are pollinated by bees. To prevent bees from searching to find nectar, bee keepers and/or growers who are managing the bees, feed the bees a mixture of sugar and water at dawn and dusk. Bees feed on the sugar and water mix as a substitute for nectar and can spend more time searching for kiwifruit pollen which increases bee movements and visits between male and female kiwifruit flowers. As bees find more attractive nectar sources

they tend to spend less time pollinating kiwifruit, therefore beekeepers can swap out their hives after a few days so that they remain focussed on collecting kiwifruit pollen.

Growers also supplement beehives by applying additional pollen to kiwifruit vines through means other than bees. This activity is called 'artificial pollination'. Growers can elect to have the flowers on their male vines picked and processed to be used for artificial pollination. There are also growers whose business is to grow male kiwifruit vines for their flowers for use in the artificial pollination of female vines. It is important to acknowledge that all cultivars of male kiwifruit vines are not always compatible with all cultivars of female kiwifruit vines. Known male kiwifruit vine cultivars used in New Zealand include: Chieftan; Matua; King; M56; M33; M91; Toumuri; Russell; Baker; Bruce; Sparkler and Meteor.

Below:
Two traditional double
box hives used for kiwifruit
pollination



There are a number of key things that growers consider when deciding to use artificial pollination. Stigma receptivity, bee activity, the use of overhead shelter, the rate of pollen to apply per hectare and the costs involved both pollen and labour. A major consideration is whether the extra cost of artificially applying pollen will attribute to financial returns.

There are many pollination devices that growers can use to apply pollen and are categorised into three broad groups:

- Contact application – like hand pollination
- Wet application – spraying pollen onto the flowers
- Dry application – blowing the pollen on

Below:
Devices which can be used for applying dry pollen to kiwifruit



Handhold Duster



Hand Held Blower



Quad Duster



Recycling Duster

3.4.1 Pollination Under Hail Netting

Zespri has been working with Plant & Food Research from early 2015 to better understand why hail netting is having detrimental effect on standard honey bee hives and to look for ways to overcome this issue. Research to date has shown that overhead nets impede the bees' ability to locate the sun's position and also suggests that a typical honey bee hive may not be the most suitable for pollinating under hail netting.

Zespri and Plant & Food Research are running research and extension activities

to establish methods for pollinating covered Gold3 kiwifruit which do not impact honey bee health. The three-year project started in spring 2016 and aims to better understand how hail nets impede bee behaviour, foraging and health, and develop beehive management guidelines for enclosed environments. Alternative approaches for pollinating covered Gold3 in the absence of honey bees will also be established, building on existing knowledge to develop new methods/technology.

Right:
Hail netting



Far right:
Honey bee attached to netting

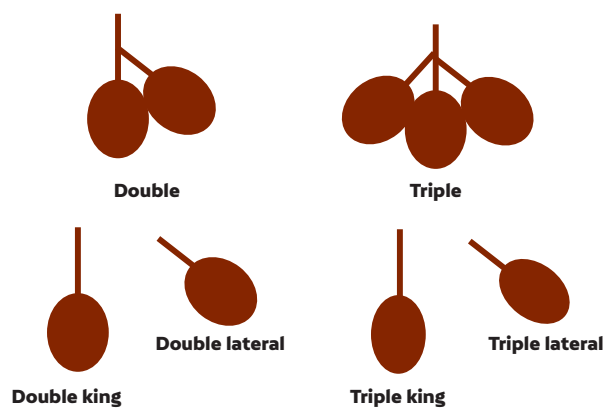


READ MORE HERE:

- <http://sciencelearn.org.nz/Science-Stories/Seeds-Stems-and-Spores/Pollinating-kiwifruit>
- <http://sciencelearn.org.nz/Contexts/Pollination/Sci-Media/Video/Artificial-pollination>
- <http://www.pollenplus.co.nz/pollination-benefits.html>

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 where defect flower buds are removed before they develop into flowers. Removal of defect flower buds aids 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:
Which fruit is king fruit and
which is lateral?

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.

The figure above is a visual illustration of the fruit thinned off. When there are two fruit growing together the fruit which is growing on the side (lateral) is removed as it will never be as big as the king fruit (the fruit in the centre). The lateral fruit will reduce the size and the dry matter accumulation of the king fruit. The same is true if all three fruit are together in a triple, the two fruit either side of the king fruit are removed.



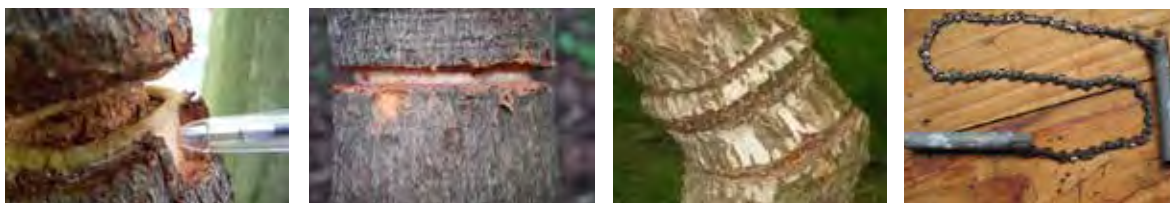
3.6 GIRDLING

Trunk girdling of kiwifruit is used to increase dry matter, increase fruit weight and increase the number of flowers the following season. The process works by isolating roots, in the period when the girdle is open, so that they cannot compete with the fruit for the carbohydrates produced by the leaves.

Kiwifruit growers often apply a girdle during both spring and summer of the same season. The summer girdle allows the fruit to attain a higher dry matter and return bloom and in spring a greater fruit size. Recent research has also indicated that pre-flowering girdling may be a useful tool in preventing bud rot (a bacterial disease causing the flowers to die) and subsequent crop losses in green varieties.

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 stem and the chain is a blunt chainsaw chain with a handle at each end that is pulled back and forth to remove the wood.

Technique is important, if the girdle is too shallow and has not gone through the phloem, the root system will still be able to compete with the fruit. If the girdle is too vigorous and cuts through the xylem 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.



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)

Below:
Girdling knife



The key is to remove all of the phloem down to the xylem around the entire stem. It can be easy to spot a girdle that has not removed all of the phloem connections – when phloem tissue is cut it turns very quickly from white to brown as the cells oxidise. If there is a fresh girdle where a part of the trunk is girdled too shallow the phloem tissue would be brown and the rest of the girdle would stay white indicating that it had correctly reached the xylem. The xylem goes brown much more slowly.

Using a tool it can take 10-14 hours to girdle a hectare of single planted mature vines, although this depends how thick and rough the bark is. Additional time will be required if the vines are double planted (two vines per bay). The chain is a lot faster, but it comes with higher risk of xylem damage and Psa expression. It is recommended that the chain is not used on young vines and cultivars that are more sensitive to Psa.

The cost can range from \$240-\$340/ha, but the benefits in increased fruit weight, dry matter and return bloom can be significant. Increase in gross orchard income of \$2,000/ha, \$11,000/ha are easily achievable for Hayward and Gold3 orchards respectively, this is clearly dependent on fruit prices and level of response. This potential additional gross income comes about from increase in fruit size (more fruit in higher paying larger counts) increased yield (more trays as larger fruit mean fewer fruit are required to fill a tray) and an increase in fruit dry matter. At 2014/2015 prices, a one percent lift in dry matter is worth \$400 and \$1,600 per 1,000 trays for Green and Gold varieties respectively. Growers may also receive additional payments for being early in the season. In most situations, it would likely that the cost to apply a trunk girdle would more than be covered by the potential financial gains.

3.7 ROOT PRUNING

Root pruning should not be confused with soil ripping, which is used to improve soil structure and drainage on heavier soils. Root pruning is used to increase fruit dry matter, this is achieved by cutting off roots and reducing the size of the root system, which in turn reduces the carbohydrate demands of the root system making more available for fruit growth and dry matter accumulation.

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 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.

3.8.1 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.

3.8.2 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-V* 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
agrchemical to dormant
vines in winter



3.8.3 Cultural Controls

Cultural controls are often simple non-chemical methods which results in more effective control of pests and diseases. Removing one large crown per vine during winter pruning reduces the number of crevices where scale can hide or allowing the grass sward under the vines to grow long during flowering causes less *Sclerotinia* spores to drift from the ground up to the canopy.

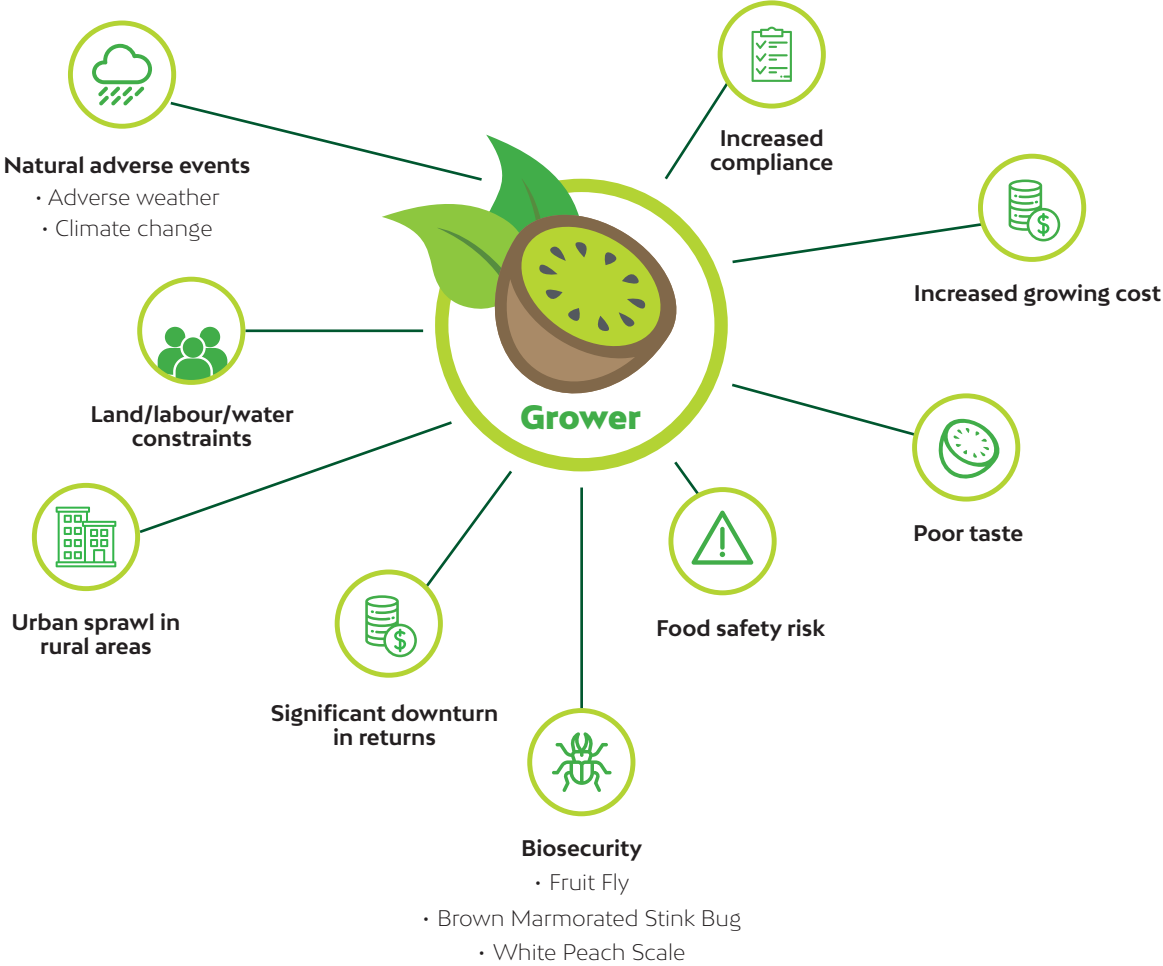
3.8.4 Orchard Hygiene

Keeping tools and equipment clean and sanitised is a key strategy for minimising the spread of pests and diseases. Virulent diseases such as *Psa-V* 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.

3.9 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 geo-political changes. Below is a diagram outlining the various risks that growers could encounter throughout their orchardist careers.

Immediate risks to growers





CHAPTER FOUR SCIENCE

This chapter is divided into three sections. Firstly, an overview on the industry's biosecurity situation is provided as well as options for pest and disease management on the orchard. Secondly, the kiwifruit industry's position on environmental sustainability is covered, including topics such as the environmental impacts of kiwifruit and the role of soil for kiwifruit growth. Lastly, the results of a kiwifruit nutrient study are presented showing how kiwifruit competes as one of the most healthy and nutritious fruit available.

THE SECTION IS DIVIDED AS FOLLOWS

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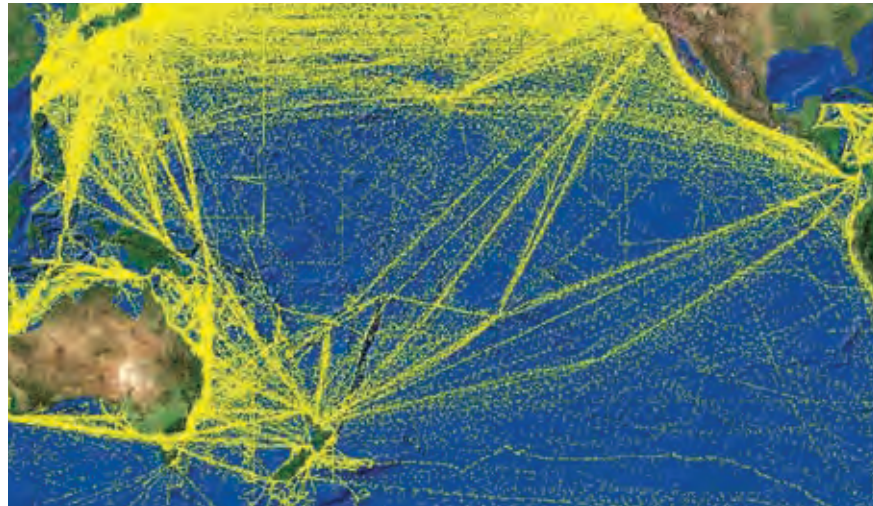
4.1 SCIENCE

4.1.1 International Shipping Routes

Worldwide, there is an increasing amount of kiwifruit loaded directly into containers at cool stores, before the containers are trucked to the wharf and shipped to receiving countries. Border officials must ensure that unwanted pests are not being transported to new locations by being lodged in cavities in a container or in soil or debris. The

image below shows in yellow, the many and varied international shipping routes of vessels entering and exiting New Zealand's ports. Border officials at each port need to be highly vigilant to ensure unwanted organisms which are currently not present in New Zealand do not cross our borders.

Right:
Map showing world shipping movements in yellow



4.1.2 Brown Marmorated Stink Bug (Halyomorpha halys)

The Brown Marmorated Stink Bug (BMSB) is the kiwifruit industry's second-most 'unwanted' biosecurity threat after fruit flies; and the risk of it entering New Zealand is considered extreme. During the 2017/18 high-risk season (September through to April) there were 283 interceptions, comprising 2,218 BMSB.

BMSB can hitchhike on inanimate objects such as cars and shipping containers from Asia, USA and Europe.

If it 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 suggest fruit loss could be up to 30% on some kiwifruit orchards.

30% fruit loss from some Italian kiwifruit orchards

\$3 billion impact on New Zealand's GDP

283 interception events at the New Zealand border in the summer of 2017/18

“ BMSB can hitchhike on inanimate objects such as cars and shipping containers from Asia, USA and Europe. If it were to enter the country it would have no problem establishing due to New Zealand’s highly suitable climate and abundance of host material. ”

Identification

The BMSB has a shield-shaped body that is mottled brown with white banding on the antennae and alternating light/dark bands on the outer edge of the abdomen. Its body is 14-17mm long and emits a pungent odour when disturbed. BMSB are larger than other shield bugs found in New Zealand.

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.

Right:
Adult BMSB with ruler to
indicate large size

Far right:
Nymph and egg mass



Right:
BMSB feeding damage on
an apple

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, this causes dimpling on the fruit’s surface and rotting and corking of the flesh (see image on the right). 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.



Distribution and Climate Range

BMSB is now present across three major continents (see map below). It is native to Asia and found in China, Japan and Korea. In 1996, BMSB invaded USA where it rapidly spread and is now present in almost every state. In 2007, it was detected in Switzerland and has now spread to 14 countries in Europe and is increasing in numbers and spreading to rural areas including Italian kiwifruit orchards. South-eastern and south-western Australia and much of New Zealand have been identified as having a highly suitable climate for BMSB.

Right:
BMSB distribution shown
in yellow



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 New Zealand has for Fruit Fly. Therefore, public reporting of suspect finds is critical. Offshore growers manage BMSB by using a range of pesticide or essential oil applications, physical barriers such as netting, traps (light & pheromone) and use of biological control agents. New Zealand is working towards pre-approval for the release of a biological control, the Samurai Wasp, should we be faced with a breeding population in the future. More details on management practices are available at STOP BMSB, a large programme of 50 researchers in the USA. Visit www.stopbmsb.org.

Right:
Nymphal stages of
BMSB. (Photo W.
Hershberger)

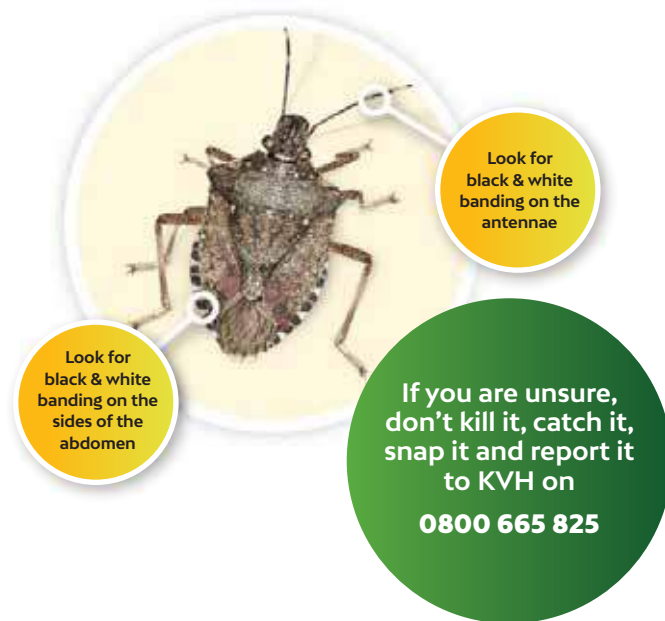


How can I identify BMSB?

There are currently other species of stink bugs found in New Zealand that could be confused with the Brown Marmorated Stink Bug (BMSB).

Key distinguishing features of the adult BMSB are:

- Its size (14–17mm);
- White banding on the antennae;
- Alternate black and white markings on the abdomen.



4.1.3 GIA (Government Industry Agreement)

The importance of being prepared for future biosecurity outbreaks is one of the biggest lessons the kiwifruit industry learnt from Psa-V. Although the industry responded well to the outbreak in late 2010, there is always the risk of another unwanted exotic pest or disease making its way to New Zealand's shores and affecting kiwifruit once again. The industry now has a better understanding of how to manage biosecurity risks, along with more tools to identify emerging risks. There is also a more engaged biosecurity relationship with government and increased capability to respond thanks to the formalising of the Government Industry Agreement (GIA) Deed 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. The agreements set out the contractual arrangements of how industry and government will work together. They establish the operational details for

readiness and response activities, including the roles and responsibilities of all the parties before, during and after a response, as well as detail on how joint activities will be cost shared.

Kiwifruit Vine Health (KVH) has so far finalised three separate Operational Agreements (OA). The first was the multi-sector agreement for the management of Fruit Fly in New

Zealand and in March 2017, KVH signed a second agreement, on behalf of the kiwifruit and kiwiberry sectors, to help reduce the damaging impacts of four sector specific threats - *Ceratocystis fimbriata*, Verticillium wilt, Psa-non New Zealand strains and Invasive Phytophthoras. A third OA for BMSB was finalised in mid-July 2017.

4.1.4 Pseudomonas Syringae PV. Actinidiae, (Psa-V)

Psa-V 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. The greatest impact from Psa-V was felt in 2013/14 when grower payments were down 17 percent to \$800.8 million due to a 55 percent reduction in volumes of Gold kiwifruit. Growers are now looking forward and having converted their orchards to a more Psa-tolerant gold cultivar, there is a general feeling within the industry while Psa-V is here to stay, it can be managed.

Psa-V is a virulent form of the disease and was discovered for the first time in New Zealand on a Te Puke kiwifruit orchard in November 2010. Since then, Psa-V has spread rapidly and now almost 80 percent of New Zealand kiwifruit orchards are affected to some degree by the disease. It has been an extremely challenging period in the

industry's history, significantly impacting orchards and kiwifruit production.

Psa-V 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-V thrives in wet, humid conditions; and multiplies quickly in wet conditions. Therefore, spring and autumn are high-risk periods for Psa-V to spread. The disease slows down in warm, dry conditions like summer.

In an orchard Psa-V 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.

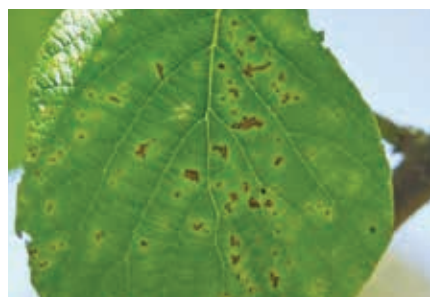
Right:
Psa-V magnified 6,000 times
(KVH)



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



Right:
Leaf spotting symptom of
Psa-V (KVH)



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



4.1.5 Industry Response to Psa-V

Right:
Media release from Todd
Muller, May 2016

Media Release

25 May 2016

Todd Muller

MP for Bay of Plenty

Muller welcomes stunning kiwifruit recovery and result

Todd Muller, Bay of Plenty MP says the Zespri result announced this morning is good for growers, good for Tauranga and good for NZ.

“Zespri and the kiwifruit industry need to be acknowledged. It was only a few short years ago the industry was under real pressure and they have turned it around superbly”.

“The annual results announced today talk to leadership, discipline and collaboration from the orchard canopy to the supermarket shelves around the world”.

“The results across all categories are powerful but the Green result is astonishing”.

“That a fruit that has been around for 50 years, and to all intents and purposes at risk of commoditisation, has become through the Zespri system a premium global food brand is the stuff of Harvard Business Reviews”.

“It is an industry that is still flat out with their 2016 harvest, but they do collectively deserve to reflect a moment on a job well done”.

ENDS

The outbreak of bacterial disease Psa-V in 2010 was a severe blow to the kiwifruit industry. It was only eight years ago that the industry was seriously questioning its future as the disease rapidly spread and growers watched helplessly as entire orchards were removed. However, the focus of conversation about Psa-V among industry and government bodies nation-wide 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-V environment. Below are 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 to take to market, as well as cultivars that are bred to be tolerant to diseases. Here is a video outlining the new kiwifruit cultivars which are Psa-V tolerant:

<http://www.plantandfood.co.nz/page/news/video-index/video/breeding-psa-resistant-kiwifruit/>

Research and Development Programme

KVH, in conjunction with Zespri Innovation, leads a global research and development (R&D) programme into Psa-V. The programme was established in early 2011 and has enlisted the best scientific minds globally to provide solutions for Psa-V. The Innovation team partners with around 20 global researchers to provide the best available expertise to the New Zealand kiwifruit industry. To read more about the R&D programme go to: www.kvh.org.nz/psa_RD.

Product Testing Programme

The KVH/Zespri product testing programme was developed to identify, rigorously test and get permission from MPI to use suitable products to help manage and control the spread of Psa-V. To date, more than 300 products have been tested for efficacy against Psa-V in the KVH/Zespri product testing programme. The KVH Recommended Product List is available for growers and includes products with proven Psa-V efficacy.

For more information about the Product Testing Programme go to: www.kvh.org.nz/producttesting.

For more information about the KVH Recommended Product List go to: www.kvh.org.nz/spray_information.

National Psa-V Pest Management Plan (NPMP)

The NPMP was established in May 2013 to help reduce the spread and impacts of Psa-V. Under the NPMP there are now industry rules governing disease management (including a year-round spray programme), monitoring, movement controls and the development of plans. These rules are outlined in a set of KVH Protocols available on the KVH website at: www.kvh.org.nz/protocols_movement_controls.

Kiwifruit Plant Certification Scheme (KPCS)

The KPCS is in place to reduce the risk of pests and diseases being spread through the movement of nursery plants. By joining the KPCS, kiwifruit nurseries demonstrate they are managing biosecurity risks, have been independently audited, visually inspected for target organisms and returned a non-detected result for a very comprehensive testing regime for Psa-V.

KPCS means that only KPCS-certified nursery plants may be bought, sold or moved between properties. However, growers may still produce plants on their own property for use on that property; and produce up to 1000 plants for movement between their own properties within the same Psa region.

For more information about the KPCS go to: www.kvh.org.nz/kpcs.



4.2 ENVIRONMENTAL SUSTAINABILITY

4.2.1 The Drivers for Sustainability and the Response

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.

Right:
Measuring the carbon in soil
on an orchard (*J Troughton*)

Far right:
Kiwifruit being unloaded at
Port of Tauranga
(*J Troughton*)



“ 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. ”

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 products. 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.

To that end, in about 2010, Zespri developed a strategy to manage the environmental risks associated with fresh kiwifruit production and consumption. Firstly, 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.



4.2.2 Mitigating Environmental Impacts

Across industry, there are examples of growers applying different techniques to mitigate environmental risks as part of their orchard management activities. Examples include better optimisation of fertiliser application timing and rate to reduce leaching or runoff and improve efficiency. Also, growers are using vegetation (riparian) zones to reduce erosion and nutrient and sediment flows into water ways. Across industry, significant gains in orchard productivity through the introduction of new cultivars and growing methods will also reduce the environmental impact per kilogram of fruit sold in market. Growers are also finding that efficiencies in water use, fertiliser application or energy usage can provide cost savings without significant losses in productivity.

Below are some key orchard impact areas and mitigation strategies.

Nutrient Management

Declining freshwater quality and availability has become a global concern. So much so that some of Zespri International's customers like Walmart and Marks & Spencer are sensitive to water-related issues and have requested information on how water is used in the kiwifruit supply chain. Although by world standards, New Zealand has clean and abundant freshwater, freshwater quality in some

of New Zealand's rural and urban areas has degraded and is coming under increased pressure as land use intensifies. A major reason for this degradation is the loss of nutrients (e.g. from urine and fertilisers) from farms into waterways.

What is 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. High levels of nutrients can also be harmful to animals including humans. Agriculture is a significant contributor to this process, particularly in New Zealand, where this sector dominates the landscape.

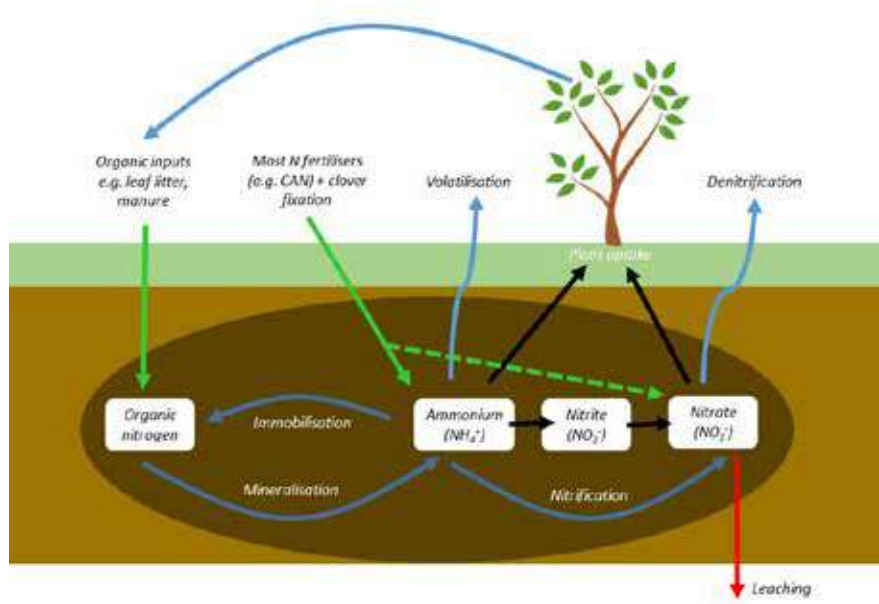
Nitrogen (N) and Phosphorus (P) are presently the main nutrients of concern and must be carefully managed as the input of these into a water body can significantly affect its quality. Consequently, there is growing social and regulatory pressure to mitigate the impacts of these. Understanding the N and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

Leaching- What is it and how does it occur?

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

Nitrogen (N) is the main nutrient risk for kiwifruit production on freshwater quality. Simply put, N applied to or already present in the soil is converted to nitrates (NO₃), which 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 image below).

Right:
Soil nitrogen cycle for a
plant-based system



How much N is applied to kiwifruit orchards and how much is leached?

Typically, kiwifruit orchardists apply 100-150kg N/ha/yr (Nitrogen/per hectare/per year). 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. The associated N losses from kiwifruit orchards are modelled to be typically less than 20kg NO₃-N/ha/yr on average (for orchards in the Bay of Plenty where most orchards are located). Such losses are low relative to those from other land uses. For example, losses from some Dairy farms in New Zealand have been reported to be as high as 80kg NO₃-N/ha/yr. Only one study of note has measured N losses

from kiwifruit orchards, however the results were highly variable. Further direct measurement is being undertaken to clarify N losses from kiwifruit orchards.

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.

Why model and not measure nutrient losses?

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 as these have dedicated kiwifruit components. OVERSEER™ is the most widely used model in NZ 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. 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 shelter-belts impede run off.



Recommended practices for sustainable nutrient management in kiwifruit

In general terms, mitigation of nutrient losses involves applying the right fertiliser, in the right amounts at the right time, and in the right place. Some 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. Furthermore, 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).

• **Don't apply when the leaching risk is high**

Apply N as late as possible in the growing season, past the wetter winter months. Do not apply when the soil is waterlogged. Applying too late after the plant requires it will impact on production and this N will be prone to leaching if the plant is not taking it up.

• **Apply only when the plant needs it**

First application of the season should be as close to bud break as possible. Applying well before in wetter months, does not advantage N uptake but increases the risk of leaching.

• **Don't apply too much**

Previous research has indicated kiwifruit vines typically required in the vicinity of 150kg N/ha/yr. Fertiliser inputs should match this and consider the process of mineralisation which can supply from an estimated 50kg N/ha/yr towards the 150 requirement. Applying higher amounts of N may not necessarily increase production.

• **Split applications**

Some of the N applied in a single application may not be taken up by the plant. Therefore, apply around 2/3rd prior to budbreak and the rest in late spring/early summer, prior to fruitset.

• **Consider less soluble forms of N**

Organic fertilisers for example are 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 are also available, however like organic forms they may not supply sufficient nutrients when required and are usually more expensive.



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 at <http://www.lawa.org.nz>.

FOR FURTHER READING SEE:

Nitrogen and Phosphorus are the two nutrients of focus:
<http://www.horizons.govt.nz>

For information on best practice fertiliser use, see
<http://www.fertiliser.org.nz>

4.2.3 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. Increasingly, retailers are asking producers to provide information on the state of orchard soils and how we manage them.

For the purposes of Zespri's sustainability strategy, soil was important to each of the five environmental impact areas. For example, it was found that the soil under kiwifruit cultivation captures and stores carbon from the atmosphere. Depending on sampling depth and soil type, it is possible to store up to 42 percent of the total greenhouse gas emissions associated with producing and delivering kiwifruit. Measuring and quantifying the role of soil carbon in relation to greenhouse gas emission associated with kiwifruit production is assisting industry in getting soil carbon recognised as a way of managing these emissions.

Storage of carbon in kiwifruit soils as organic matter occurs because of how orchards are managed. 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

“Globally, health and quality of soils is also seen as important by consumers, retail customers and society.”

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 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



4.2.4 Agrichemical Use

Agrichemical use in all horticultural systems is required to achieve desirable production outcomes. However, agrichemicals usually have environmental and human health risks associated with their use and it is therefore important to understand and prevent these occurring. The following processes exist in the kiwifruit industry to mitigate these risks:

1. Zespri operates a good agricultural practice assurance programme 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 page 121).
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 diary 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 R&D to identify safer agrichemicals.



Copper Case Study

Below is a case study on copper which is commonly used to control the Psa disease.

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. 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-V.

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 bodies 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 honey bee acute toxicity study indicated that copper is practically nontoxic to honey bees.

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 is considered as a micronutrient for plants. Enhanced industrial and mining activities have contributed to

the increasing occurrence of copper in ecosystems. Excess copper in the soil can induce stress and cause 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 rate

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.

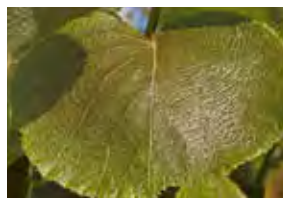
Zespri works closely with growers to ensure that copper, a critically necessary tool to manage Psa, is used effectively with minimum environmental impact. An upper limit is placed on the amount of copper that a grower can apply in one year and this is closely monitored by Zespri – 8 kg/ha/yr for conventional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



Leaf speckling



Leaf burn at the leaf margin



Bronzing of the upper leaf surface



Brown staining of leaf veins



4.2.5 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 2017, about 165 orchards in New Zealand were growing organic kiwifruit representing about 480 hectares. 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 percent 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

4.2.6 Measured Environmental Impacts of Kiwifruit

CARBON FOOTPRINT

Carbon footprint is the overall amount of greenhouse gas emissions, consisting primarily of carbon dioxide, associated with an organisation, event or production. It is one of the most common measures of the effect of an individual, community, industry, or country on the environment. An increase in greenhouse gas emissions, and therefore in carbon footprint, is the primary event associated with climate change that has led to global warming (Source:<http://www.livestrong.com/article/183436-the-importance-of-reducing-a-carbon-footprint/>). Some businesses are interested in carbon footprinting as it allows them to identify efficiencies and in doing so save money. Globally the aim is to reduce greenhouse gasses.

In 2009, Zespri published the carbon footprint for Hayward kiwifruit grown in New Zealand and consumed in Europe. This was 1.74kg of carbon equivalents per 1.0kg of kiwifruit across its lifecycle from orchard to consumer. The break down was as follows:

- Orchard operations made up 17 percent;
- Packhouse and coolstore processes accounted for 11 percent;
- Shipping accounted for 41 percent;
- Repacking and retailer emissions made up 9 percent;
- Consumer consumption and disposal comprised 22 percent.

FOR MORE INFORMATION VISIT:

<http://www.landcareresearch.co.nz/science/living/sustainable-business/carbon-footprinting/zespri>

“ Carbon footprint is the overall amount of greenhouse gas emissions, consisting primarily of carbon dioxide, associated with an organisation, event or production. It is one of the most common measures of the effect of an individual, community, industry, or country on the environment. ”



WATER FOOTPRINT

The water footprint is an indicator of freshwater use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater used to produce the goods and services consumed by the individual or community or produced by the business. Water use is measured in terms of water volumes consumed (evaporated or incorporated into a product) and/or polluted per unit of time. A water footprint can be calculated for a particular product, for any well-defined group of consumers (for example, an individual, family, village, city, province, state or nation) or producers (for example, a public organisation, private enterprise or economic sector). The water footprint is a geographically explicit indicator, showing not only volumes of water use and pollution, but also the locations (Source: <http://www.waterfootprint.org>).

Water footprint has emerged as a response to global concerns about water scarcity and some Zespri customers are sensitive to this. They may therefore ask Zespri water-related questions around how much water is

used to produce kiwifruit in total and per unit of kiwifruit which is called the “water use efficiency”.

In New Zealand, water in some areas are over-allocated which means water needs to be managed carefully to ensure the needs of all stakeholders are met and that producers are not being disadvantaged by having insufficient water.

The water footprint for Zespri Green Kiwifruit was published in 2011. It was reported that 417L of water was used to produce a kg of fruit or 42L per piece of fruit. Most of this water was provided by rain.

FOR MORE INFORMATION VISIT:

<http://www.landcareresearch.co.nz>

<http://www.scoop.co.nz/stories/BU1107/S00014/zespri-quantifies-kiwifruit-water-footprint.htm>

<https://www.zespri.com>

<http://www.radionz.co.nz>

4.2.7 Water Management

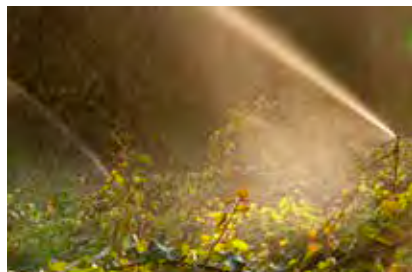
Access to water is essential to the success of our industry and a key economic advantage for New Zealand in an increasingly water constrained world. It underpins horticultural production – the combination of water availability, climate and geography gives us a competitive edge internationally. In kiwifruit, water is primarily used for the following:

1. For young vines when orchards are being established.
2. To protect vines from frosts in spring and autumn.
3. To prevent mature vines from becoming stressed in summer in locations where soil moisture content is low.

Water is also needed for spraying, but the amounts needed are relatively small compared to what is needed for the above.

In New Zealand, water in some areas is over-allocated which means water needs to be managed carefully to ensure the needs of all stakeholders are met and that producers are not being disadvantaged by having insufficient water. It is vital that water use on orchards complies with the Resource Management Act (RMA), Regional Council rules and any industry GAP (Good Agricultural Practice) programmes. These are in place to protect the environment and to ensure water shortages don't occur. For more information on GAP see Chapter 8.

Right:
To protect kiwifruit vines from frost, water is delivered via overhead sprinklers



National Policy Statement for Freshwater Management (NPS)

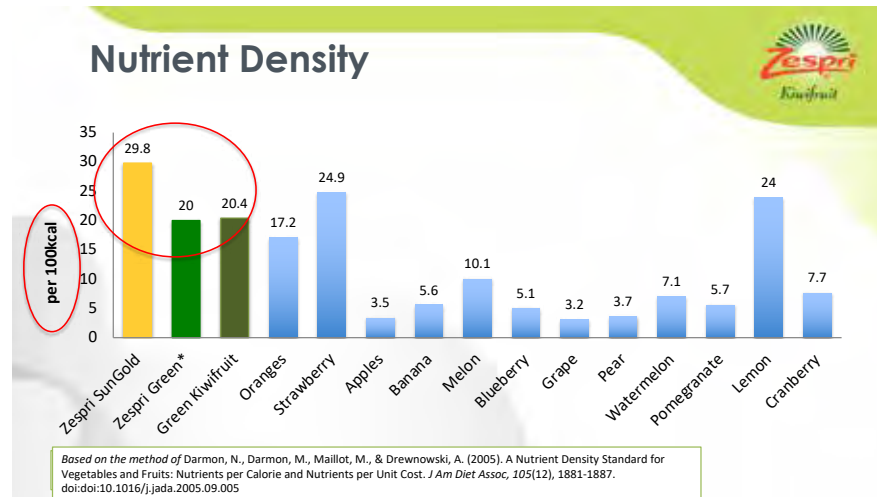
The clearing of native vegetation, New Zealand's growing population, urbanisation, farming/forestry, the drainage of wetlands and the damming and modification of rivers and streams have all had significant effects on our land and placed increasing pressure on our water bodies and their ecosystems. In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

Regional Councils are currently implementing the National Policy Statement for Freshwater Management. Councils are required to implement the Freshwater NPS in their policies and plans no later than 31 December 2025. Details of each regions implementation programme is available on the Ministry for the Environment website <http://www.mfe.govt.nz/fresh-water/national-policy-statement/regional-councils-implementation-programmes>.

Regional resource consents for the abstraction of water

Resource consents allow people or organisations to do something that may have an effect on our environment. How much water you can take will depend on where you live as each region has different limits. Contact your local regional authority to find out more information on the consent process in your region.

4.3 THE NUTRIENT ADEQUACY SCORE OF KIWIFRUIT



Right:
Nutrient adequacy score of
kiwifruit

Actinidin

Kiwifruit contains actinidin, a highly-active proteolytic enzyme of the cysteine protease family, so called after the scientific name of the green kiwifruit vine, *Actinidia Deliciosa*. This enzyme has the ability to hydrolyse a wide range of food proteins more completely and faster than the digestive enzymes can do on their own. Recent in vitro and in vivo studies in rats and pigs have shown that eating green kiwifruit with a protein-rich meal improves the digestion of the proteins, particularly in the stomach. Actinidin can increase the absorption of proteins in the small intestine by improving the gastric digestion of proteins. 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.

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 benefits for digestive health, the regulation of glucose in the blood, and blood cholesterol levels. It also promotes the growth of beneficial bacteria in the colon and helps to control weight. Good quantities of fibre are found in wholegrain cereals, pulses, fruits and vegetables. There are two types of fibre, and both of them are necessary for good health:

- Soluble fibre (pectins and gums): Helps to lower blood cholesterol levels, and can help to reduce constipation. Found in fruits, vegetables, oat bran, barley, flax, seeds, dried beans, lentils, peas and soya milk.
- Insoluble fibre (cellulose, hemicellulose and lignin): The main effect of this type of fibre is to increase the bulk of the stools and to alleviate constipation and associated problems such as haemorrhoids. Found in the husks of wheat, maize and rice, the skins of fruits and vegetables, nuts, seeds, legumes and wholegrain cereals.

Right:
Fruit fibre content
comparison graph



Vitamin C

Vitamin C is an essential vitamin for human nutrition. It plays a significant role in maintaining good health by influencing various components of the immune system, 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. This means taking more vitamin C could reduce the sensation of fatigue and increase physical and mental energy. The human body cannot synthesise vitamin C. This means that, in order to maintain good health and vitality, we must regularly eat foods that contain vitamin C. 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

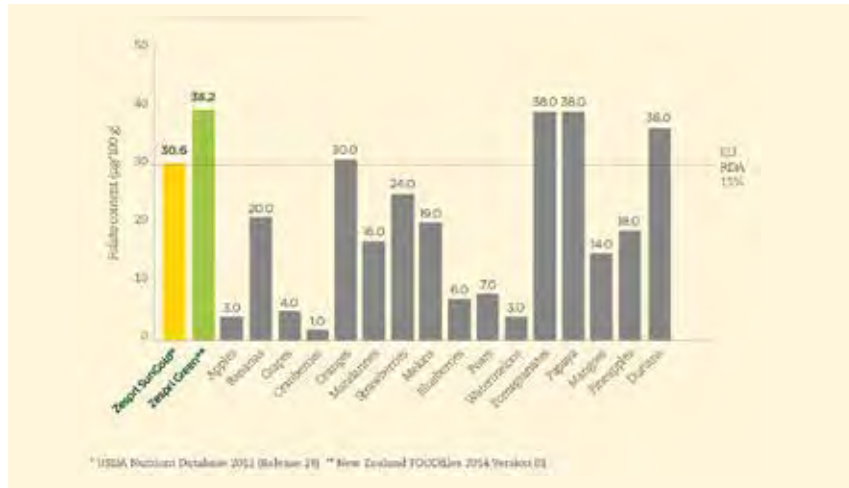
Right:
Vitamin C content
comparison graph



Folate

Folate is an essential nutrient for cellular growth and development and is vital for the formation of the erythrocytes which transport oxygen, iron and other minerals. Folate performs important functions in the healthy body, and sufficiently high levels are needed before and during pregnancy. It is also vital for infant growth. Some of its functions include; growth of tissue during pregnancy, normal formation of amino acids, normal formation of blood cells, normal formation of homocysteine and normal psychological function.

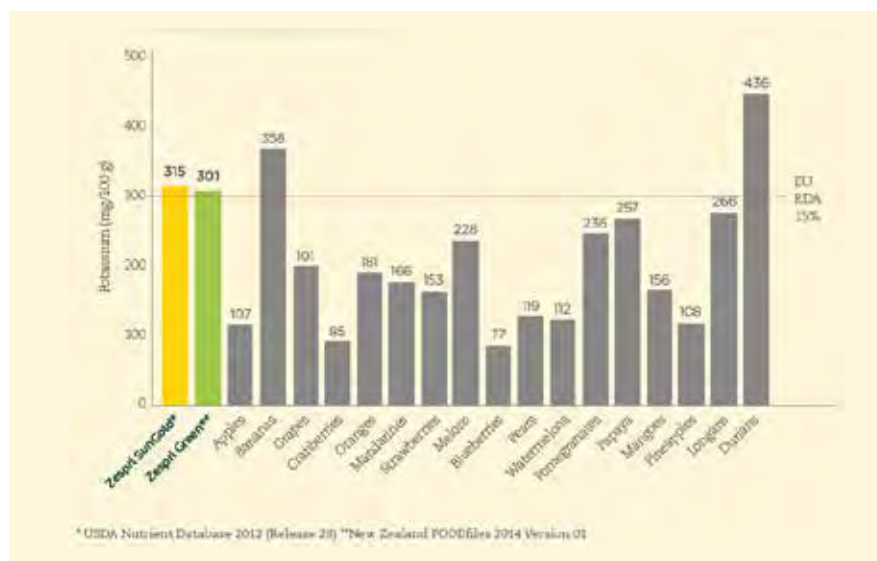
Right:
Fruit folic acid content
comparison graph



Potassium

Potassium is an important mineral for the development of many different body functions. In particular, it contributes to the normal function of the nervous system and is necessary for muscular contraction. Fresh foods such as fruits, green vegetables and cereals or wholemeal bread are generally high in potassium and low in sodium. Kiwifruit is a natural source of potassium.

Right:
Fruit potassium content
comparison graph



Antioxidants

Antioxidants are found in certain foods and neutralise free radicals, helping to reduce the damage caused by oxidation. Despite the vitamin E levels are not that high in kiwifruit, Zespri Gold and SunGold contain a relatively high quantity of vitamin E compared to other fruit. Research has shown a significant increase in plasma antioxidant measures following the consumption of kiwifruit compared to the consumption of other fruit and foods. Kiwifruit contains a wide range of antioxidants, such as vitamin C and polyphenols. The polyphenols present in both Zespri Green and Zespri SunGold Kiwifruit also have an antioxidant effect.

Low Glycaemic Index

The Glycaemic Index (GI) indicates the amount of glucose that is released during digestion from carbohydrates into the blood system.

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

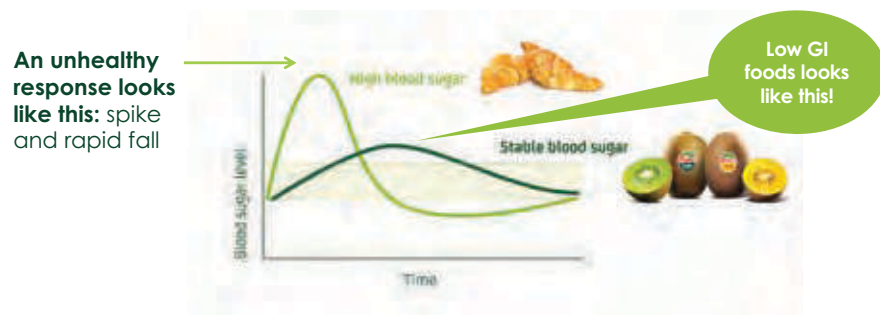
The Glycemic Index (GI) for the three varieties of Zespri Kiwifruit is:

- Zespri Green: **39**
- Zespri Gold: **49**
- Zespri SunGold: **38**

The carbohydrates available in ripe kiwifruit are a mixture of glucose, fructose and sucrose in a proportion of 2:2:1. Of these sugars, glucose has a GI of 100% (the benchmark), fructose 19% and sucrose 68%. There are other factors capable of reducing the speed of absorption of glucose, i.e. the GI. In the case of kiwifruit, it has been observed that the impact it produces on plasma glucose levels is less than its Glycaemic Index - in other words very low. For this reason, kiwifruit is a healthy option for people with a reduced tolerance to glucose, for example people with diabetes.

Right:
How foods affect your
blood sugar

Foods differ in their impact on blood sugar





CHAPTER FIVE BUSINESS

This chapter covers a range of topics that come underneath the commercial umbrella. Firstly chapter 5.1 examines Zespri's marketing strategies and campaigns 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.

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5.1 ZESPRI'S ROLE: MARKETING AND INNOVATION

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

- Focus on innovation to develop new varieties, productivity and sustainable growing techniques.
- Developing advanced supply chain systems to distribute premium quality kiwifruit.
- Researching the health benefits of kiwifruit with credible research partners.
- Establishing strong brand awareness and in-market service.

Zespri's long-term strategy sits under its three pillars as depicted in the Global Strategy graph below:



Zespri's Strategic Drivers are as follows:

Increase Demand: To meet the ambitious goal of \$4.5 billion in kiwifruit sales by 2025, Zespri has to grow sales in new markets and develop new opportunities in existing markets. One example of this is the Zespri team in Japan who grew sales in the longstanding highest-value market by more than 16 percent to 24 million trays in the 2017/2018 season.

Fulfil Demand: In order to develop the supply chain to fulfil even higher levels of demand, a fundamental aspect is to build a sustainable and productive 12-month global supply base. Success in fulfilling demand also requires Zespri to continually drive the delivery of high-quality, good-tasting fruit from the orchard, through the supply chain. The focus on taste is highly important because of the potential for new competitor varieties coming into the market.

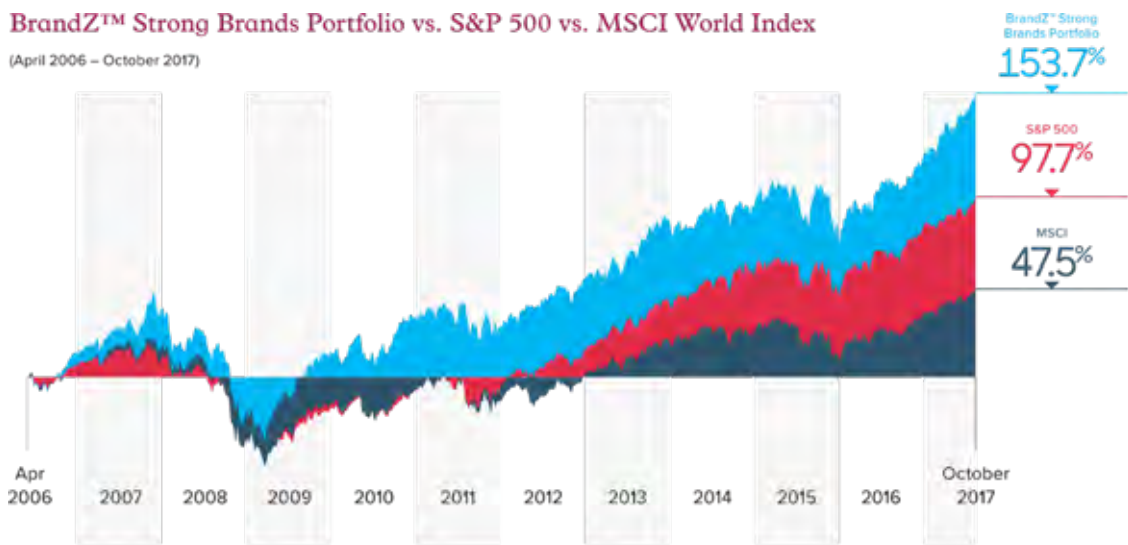
Innovate: Innovation in platforms such as new cultivars, protecting fruit from pest and diseases, sustainable orchard productivity, optimising how customers are delivered high-quality fruit and creating knowledge for health communications. Other innovation is in future technologies and innovation across Zespri.

5.1.1 Brand and Marketing

In the 2017/18 financial year, Zespri invested over \$140.4 million in marketing Zespri Kiwifruit, representing approximately 5.9 percent of sales revenues. Zespri's marketing strategy is focused on rapidly growing demand ahead of supply. It includes attracting new customers to the category, building penetration among fruit eaters and increasing consumption among occasional users.

Zespri is at a pinnacle stage in its evolution, with the business in the process of evolving from a product-centric organisation to a consumer-driven one. This change has been led by Zespri's marketing team who realise the immense value consumer-centricity can bring to the entire business and how critical it is for Zespri's future success. Companies that invest in developing strong brands significantly outperform those that don't, and brands which consumers perceive to be meaningful and different grow the fastest.

Below:
Research completed by Millward Brown illustrates how much impact a strong brand can have on a company's performance



Source: BrandZ™/Kantar Millward Brown (including data from Bloomberg)

Zespri's global marketing plan has very clear guidelines on how to maximise the results and effectiveness of Zespri's marketing investment. Zespri's Market Development Framework was created to help the business determine the appropriate level of investment based on the market's stage of development. The four stages of development are: **Explore, Launch, Establish & Enhance.**

Zespri sells its fruit into 50+ markets around the world. In order to execute its strategic goals Zespri has segregated its key markets by their stage of development. Every market is unique and has different requirements but generally in the early stages of development, the **Explore** stage, 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 the USA is the only market in the launch stage of development. As markets continue to grow and develop, the focus shifts to increasing usage (**Establish**) and emphasizing consumer benefits to enable a greater premium (**Enhance**).

The marketing plans developed in each country are consistent with Zespri's global strategy, yet highly tailored to the local market conditions – Consumers' attitude to fruit, their familiarity with kiwifruit, the level of development and engagement with the Zespri brand, their local language, culture and customs. One of the main reasons Zespri has been able to establish itself as one of the world's leading fruit brands is its 'think global, act local' approach, which makes sure that all communication and activities are relevant for the local consumers. Below are two international marketing examples showing how the 'think global, act local' approach is applied to international campaigns.

2016 Marketing Campaign: Zespri Green Kiwifruits Are Sweeter Than You Think

Despite being a superfruit, Green Kiwifruits have chalked up a reputation for being sour over the years and this has proved to be one of the top purchase barriers globally. To debunk the age-old misconception, Zespri launched an entertaining thematic campaign – Sweeter Than You Think – to encourage consumers to give this fuzzy fruit another try.

Kicking off with a series of videos depicting tough guys in a song-and-dance, belting out their stand to look beyond the exterior and discover the sweetness inside – very much like the Zespri Green Kiwifruit, which is sweeter than you think when enjoyed softer and ripe. A central website educates with bite-sized pieces of advice in the form of light-hearted videos and is supported with print, radio, social media and on-ground sampling of ready-to-eat Zespri Green Kiwifruit, all in a bid to drive this message forward.

"Sweeter Than You Think" spans across nine countries in Asia- Pacific including China, Korea, Singapore, Thailand, Vietnam, Indonesia, Malaysia, Taiwan and Hong Kong. Discover the secrets to greater-tasting Zespri Kiwifruits at www.SweeterThanYouThink.com



2017 Marketing Campaign: Zespri Japan Challenge Local Marketing Conventions with New Product-Centric Approach: The Kiwifruit Brothers

Japan is Zespri's most established market. Due to its level of maturity, increasing sales volumes in Japan is no easy feat. This challenge is further amplified by the fact overall fruit sales in Japan are on a negative trend, declining year on year. In order to significantly increase its sales volumes Zespri's Japan team had to rethink their traditional approach to marketing.

Japan is well-known as a market that's heavily saturated in advertising media, each year approximately 18,000 new TV commercials are introduced to consumers. Traditionally most advertisers use celebrities to promote their products and Zespri was no exception. However, this approach is known to be costly and the Zespri Japan Team found the investment would often work well to promote short-term sales but wasn't so effective at increasing awareness of the Zespri brand in the long-term as consumers were more likely to recall the celebrity rather than the Zespri brand or product.

After comprehensive consumer insight analysis, the team came up with a new product-centric solution – The Kiwi Brothers. Two mascots were designed to represent Zespri Sungold and Zespri Green kiwifruit. The award-winning characters have proved tremendously popular with consumers and helped increase brand awareness and resonance for Zespri in Japan.

The team's next challenge was to get Zespri's sales partners on board with the new programme. This involved the creation of instore displays across Japan using 13,000 sets of the mascots! The instore material was supported with an integrated animation-based TV commercial, plus communication through digital media, fruit sampling and packaging, to establish the loveable mascots as enduring, iconic characters in Japan.

The end result of the team's innovative sales and marketing efforts has resulted in sales increasing by 30 per cent in this crucial market between 2015 and 2017 and the Zespri team is aiming to further increase sales by 25 percent over the next five years.



Other examples for Zespri promotion – have a look on YouTube to see some of the examples of how Zespri kiwifruit is promoted around the world.

Singapore: <https://www.youtube.com/watch?v=ta0mxNComV4>

China: <https://www.youtube.com/watch?v=bzGv0tRO66A>

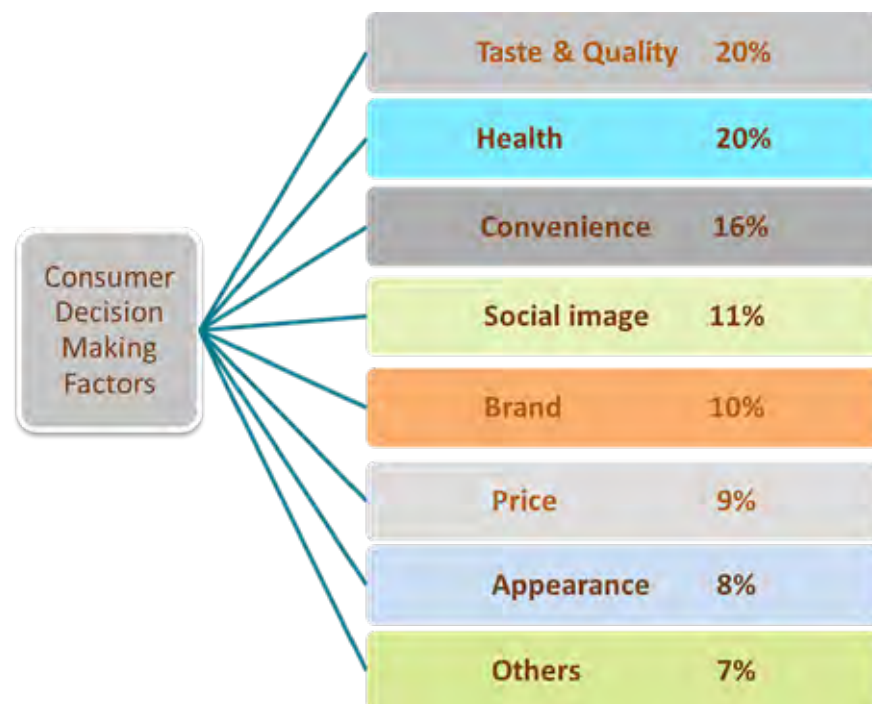
France: <https://www.youtube.com/watch?v=0iaEs7c-Ups>

Malaysia: <https://www.youtube.com/watch?v=znWC1wuaWPg>

“ Health marketing is a key part of Zespri’s strategy. After taste and quality, health is one of the major reasons consumers buy Zespri Kiwifruit. ”

Zespri’s dedicated investment in sales and marketing programmes continues to build the premium reputation of Zespri kiwifruit and supports the high quality, taste and healthy positioning that consumers know and trust. Zespri is the category leader within kiwifruit and is recognised as one of the strongest fruit brands globally. Despite Zespri’s current position, Zespri is committed to continuing to grow and develop the brand with the end-goal of one day becoming one of the world’s top 50 food brands.

5.1.2 Health Marketing



Right:
Project Healthy 2007
– Consumer survey
understanding why
consumers buy Zespri
Kiwifruit

Health marketing is a key part of Zespri’s strategy. After taste and quality, health is one of the major reasons consumers buy Zespri Kiwifruit. Zespri has researched the health benefits of kiwifruit for many years and recently these findings were overlaid with what consumers identified with to determine health marketing strategy. The diagram on the following page summarises the health benefits of kiwifruit into three pillars. Each pillar represents an area where there is scientific evidence of a health benefit and is an area that consumers identify with and report being a reason that they purchase kiwifruit.

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 mgmt / diabetes	contains	natural source pregnancy	contains muscle function	contains

Above:
The three health communications pillars within the Zespri health strategy

5.1.3 Developing New Markets

In **2017/2018** Zespri sold **151.7 million trays of kiwifruit (3.55kilo/tray)**. The dip in production in the graph below during 2011-2013 shows how crop volumes were impacted by the bacterial disease PsA-V. Zespri's challenge is to develop demand ahead of supply to maximise returns to growers. As the graph shows below, Zespri has a confident view of demand and aims to produce **263 million trays by 2025**, which will see global sales revenues increasing to 4.5 billion.

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



The production of kiwifruit grown in New Zealand is increasing. To maintain value, as production increases so must demand. In 2017, most trays went to China, followed by Japan, Spain and Portugal (see graph below).



“Kiwifruit is still an underdeveloped category within the fruit bowl but with huge growth potential.”

5.1.4 Supply and Demand of Kiwifruit

Zespri’s sales and marketing investment works to create demand ahead of forecast supply. However, in order to achieve market demand, strong and sustained market returns are essential for growers, postharvest operators and Zespri in order to support and encourage the collective supply investment required.

Kiwifruit is still an underdeveloped category within the fruit bowl but with huge growth potential. This means that there is space to occupy and advantage to be gained through scale. However, with growth and success also comes competitor risk. The following factors may affect or impact the supply and demand of kiwifruit:

Supply

- Seasonality. Production of kiwifruit in New Zealand is seasonal, therefore to maintain market share in an increasingly competitive market Zespri works to produce a 12-month supply by growing fruit in offshore regions such as Italy and recently trialling the establishment of orchards in China.
- Adverse weather such as frost, cyclone, drought, etc
- Biosecurity incursion
- Food safety/contamination risks
- Labour constraints

Demand

- Growers produce a crop increase in excess of what the markets demand resulting in extra fruit that has to be crop managed
- Markets cannot develop at the expected rates, lowering return on investment for growers and potentially delivering growers with lower profitability than planned
- Market access is lost to a significant market due to political changes
- A significant new competitive gold variety emerges to compete with Zespri's Gold varieties
- A new competitive fruit takes market share from all other fruits
- Green supply declines impacting Zespri's ability to offer a full portfolio of kiwifruit products in order to hold shelf space. This could happen if an increasing number of growers decide to graft over to alternative varieties
- Organic supply cannot be increased, leaving a gap in Zespri's product offering
- Growers are unable to meet the quality specifications and delivery requirements of markets



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 with 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.

An increase of organic production

Organics are a significant opportunity for all fruit groups, with potential to grow in most markets.

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.

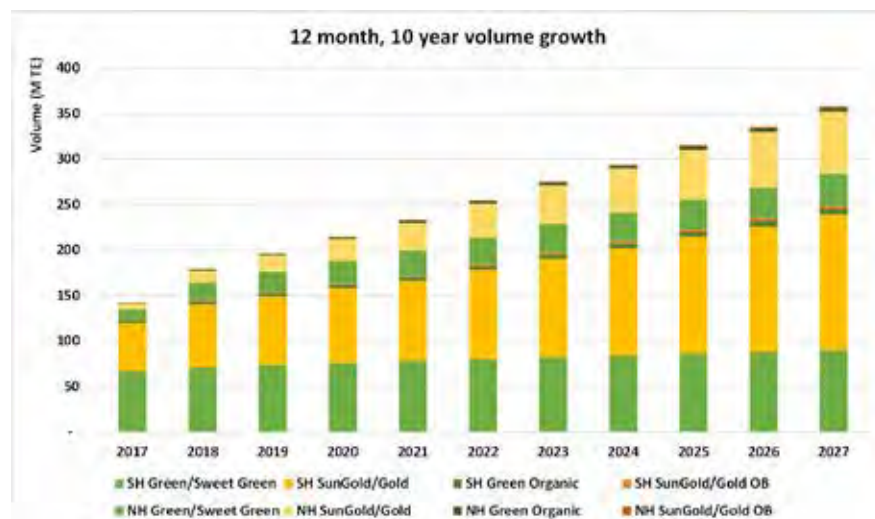
Innovation

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

Zespri's 10-year overview of demand and supply

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.





5.2 ZESPRI'S ROLE IN THE INDUSTRY - STANDARDS

Zespri focusses on being able to supply optimal quality throughout the season and continues to lead the category of commitment to food safety and sustainability. A huge amount of effort, across the supply chain, goes into ensuring Zespri kiwifruit that gets to the consumer is of the highest quality. The size, quality, 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 and research undertaken by industry. The following quality requirements are described in this section:

- Fruit Size (Section 5.2.1)
- Taste/ (TZG) Taste Zespri Grade (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)
- Consistency of Supply (Section 5.2.7)

5.2.1 Fruit Size

Fruit sizes range from size 16 to size 46. '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. Fruit that is smaller than size 39 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 Green14 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 Gold 3, 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 bio-stimulants, 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 2018

Cultivar	Preferred average size
Green	31.8
Organic Green	33.5
Sweet Green (Green14)	33.0
Gold3 and Organic Gold3	29.3

“ One reason Zespri Kiwifruit achieve a significant premium in the market is superior taste. ”

5.2.2 Taste (Taste Zespri Grade TZG)

Taste is primarily driven by the amount of sugars and acids in the fruit. Both sugars and acids 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.

One reason Zespri Kiwifruit achieve a significant premium in the market is superior taste. Zespri encourages growers to maximise taste by reflecting these market signals in grower payments. The level of sugar in ripe fruit is determined by the level of starch, or dry matter, in the fruit at harvest. A sample of fruit is collected from each orchard before harvest and the percentage dry matter measured. A significant part of the payment growers receive for their fruit depends on the level of dry matter. This is called the Zespri Taste Programme.

This programme was launched in 2001 in an effort to enhance the overall quality of Zespri Kiwifruit, by improving taste. Taste Zespri Grade (TZG) was

Sugars + Acids = Taste
Taste + Aroma = Flavour

originally based on the premise that Japanese consumers preferred a sweeter tasting kiwifruit and were prepared to pay for it. TGZ calculations are based on the dry matter measured for each maturity area in an orchard and the size profile of fruit in each area. Our objective is for the Zespri-branded portfolio to represent the best-tasting kiwifruit in each segment (Green, Gold, and Red etc.) and for this superior taste experience to be consistently delivered to the consumer. To achieve this objective, Zespri has integrated 'Taste' as a commercial target for growers. Through consumer research, acceptance and preference thresholds for all commercial cultivars have been established. A maturity criteria programme and payment mechanism have been developed to incentivise growers to grow fruit that is aligned to market requirements.

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. For Hayward, Hayward Organic and Gold3 cultivars 70% of the fruit in a maturity area must have a dry matter above the MTS. For Green14 the MTS is a minimum average dry matter. The MTS for each variety provides a benchmark that growers need to exceed for fruit to be accepted for export by Zespri. This minimum standard, and the payment premiums for higher TZG fruit, incentivises and rewards growers for producing the greater tasting fruit that the market requires. Fruit that does not meet the MTS, and is therefore not acceptable for export, is either processed or used as stock food.

In 2016, the Gold3 taste-by-size model was introduced where fruit weight is used to help predict dry matter for each size.

Fruit that does not meet the MTS is not accepted by Zespri for export. This fruit is

either processed or used as animal feed. Once dry matter has been calculated it is allocated to the relevant count size and depending upon the distribution of the dry matter a calculation is made to arrive at a TZG figure. Fruit that does not meet the MTS will be further segregated into taste bands. 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.

Growers are incentivised financially to grow the right taste band fruit. The higher the TZG the grower achieves the greater proportion of the maximum taste payment (MTP) the grower will receive. The MTP is calculated by Zespri and is reflective of higher value that consumers place on a superior taste experience. In the 2017/18 season the MTP for Hayward was \$4.34 per tray whilst Gold3 had a MTP of \$8.08 per tray. The grower's TZG is multiplied by the MTP to calculate their taste payment.

As outlined in chapter 3, there are lots of practices growers can consider throughout the year to increase their dry matter. This includes:

- Increasing the temperature of the orchard (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: Minimum Taste Standard by Cultivar in 2018

Cultivar	Dry Matter average required
Hayward	70% of fruit at or above 15.5%
Gold3	70% of fruit at or above 16.1%
Green14	16.8% or more
Hayward Organic	70% of fruit at or above 15.5%

Delivering taste and consistency

At a high level, there are a number of key components that need to be understood and managed to optimise the delivery of taste and consistency, namely:

1. Cultivar
2. Growing environment, vine management and season
3. Maturity criteria and 'Ship-By' rules
4. Dry matter
5. Sugars, acids and volatiles (composition and change through temperature/time)

6. Physical appearance
7. Curing, storage and ripening regimes (temperature/time components)
8. Value chain and programmes like 'Ready to Retail/Ready to Eat'
9. Market and consumer preferences
10. Taste Zespri evolution and inventory segregation/management

The above list, while not exhaustive, demonstrates the number of variables impacting on the delivery of taste and consistency.

See the image below for more information.

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. Flesh colour is measured using a chromometer. The clearance criteria requires at least 87/90 fruit to meet the minimum colour standard. The 87th fruit is called the fractile.

Right:
Fruit sample cultivar in 2018

Cultivar in a 90 fruit sample	
Gold3 KiwiStart	Green fractile 112.9 ^o hue
Gold3 Mainpack	Green fractile 109.3 ^o hue
Green14	A Gold fractile of 109 ^o hue

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

<https://www.youtube.com/watch?v=Utlwp6DsfXg>

<https://www.youtube.com/watch?v=Tmfb0VgjN1U>

https://www.youtube.com/watch?v=hKQj_Wikq_A

Visit www.freshfacts.co.nz for the latest industry statistics and find out how kiwifruit compares with other horticultural exports such as pipfruit. Also refer to the 2017/18 Zespri Annual Report and Review available on their website www.zespri.com.

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 Intergrated 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.

Read more here: <http://www.zespri.com/companyinformation/newsroom/increaseitaliansungold>

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.

Zespri currently sources non-New Zealand supply from Italy, France, Greece, Portugal, Japan, and South Korea and is assessing the capability to supply a premium quality kiwifruit grown in China, and developing supply partnerships to underpin a sustainable long-term business.

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.

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 Leaders in Innovation

Zespri's innovation investment aims to create value across the supply chain from breeding to consumer. To do this Zespri invests across five innovation platforms:

- New cultivar development (breeding and advanced selections)
- Sustainable production systems (on-orchard productivity, crop protection and biosecurity)
- Sustainable delivery of fruit (food safety and market access, fruit physiology, taste and quality, engineered supply chain)
- Value addition and creation (health and nutrition, convenience, consumer understanding)
- Research investment in Psa-V management tools and techniques continues, integrated across the

on-orchard productivity and crop protection portfolios.

New Cultivar Development

Kiwifruit come from the Genus *Actinidia* and the New Zealand commercialised cultivars from both the *Deliciosa* and *Chinensis* species. All *Actinidia* species are perennial climbing plants (vines) and almost all species are deciduous (some are only partially so). There is greater genetic diversity in kiwifruit than there is for apples. New Zealand researchers have been collecting kiwifruit genetic material over several decades and now have the largest selection of kiwifruit genetic material outside of China. New Zealand has a kiwifruit vine library planted in Te Puke, New Zealand that is used to breed different cultivars based on research into what future consumers will demand.



Above:
An example of different types of kiwifruit cultivars planted in Te Puke

“There is greater genetic diversity in kiwifruit than there is for apples.”

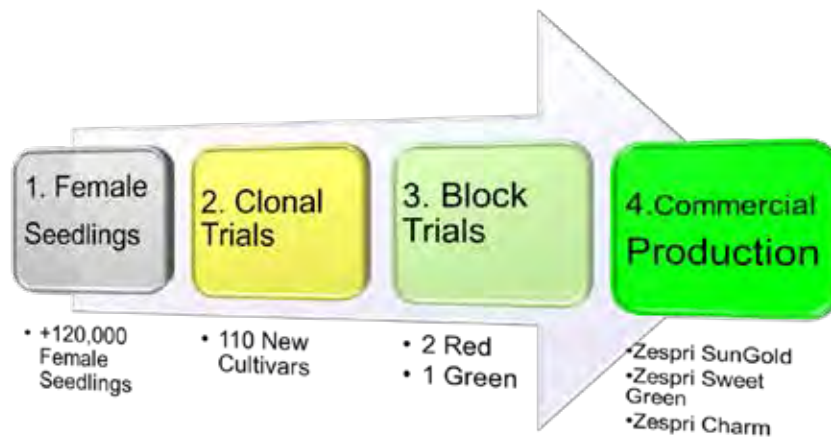
In 1997, the first Gold kiwifruit cultivar was launched and it was a very successful alternative variety to Hayward. Zespri Gold was bred by Plant & Food Research and commercialised and marketed by Zespri in 2000. Zespri Gold was the first gold fleshed kiwifruit available in the market in the world. In economic terms Zespri had 'first mover advantage' which led to price premiums in the market that have been extremely profitable. Since Zespri Gold was commercialised, it has led to an economic benefit to New Zealand of over \$4 billion. Prior to the bacterial disease Psa incursion Zespri Gold also generated more than \$525 million in annual global revenue.

Right:
Zespri Gold



Zespri has an operating agreement with NZ's Crown Research Institute (CRI) for Plant & Food Research. Plant & Food Research is responsible for the parental development of kiwifruit cultivars, and supplying the tools associated to speed up the Breeding Pipeline. In the breeding pipeline currently there are over 120,000 female seedlings, 110 new cultivars, two red and one green cultivar in block trials and three cultivars in commercial production.

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



For a new cultivar to progress through the new cultivar pipeline it needs to exceed product attribute thresholds. The product attributes include taste, nutritional composition, fruit size, shape and skin type, pest and disease resistance, harvest timing and storage keeping ability.

Zespri is responsible for new cultivar development including commercialisation of new cultivars. In June 2010, three more cultivars were commercialised, known as Gold3, Gold9, and Green14. Gold3 and Gold9 were developed to extend the Zespri Gold market window. Green14 has green flesh with higher sugar content than 'Hayward' and was bred to establish a new market segment.

Right:
Picture displaying Zespri's
current commercial cultivars.
From left to right: Organic
Green, Organic SunGold
Green, SunGold, and
Sweet Green



The key commercial cultivars for New Zealand are Hayward (Green), Gold3 (SunGold), Green14 (Sweet Green), and Organic (both Green and SunGold). Also still produced but in declining numbers due to Psa, is Hort 16A. For more information, visit www.zespri.com/varieties. The combination of a single marketing desk and commercialised cultivars has led to the kiwifruit industry becoming a billion-dollar fresh kiwifruit exporter. Further extensive plant breeding continues to be undertaken.

The De-commercialisation of G9

In 2010, Charm (G9) joined the Gold variety mix as a high taste fruit with expected long storage characteristics. The variety was relatively easy to grow and had high yields. In early production it became clear there were issues with the fruit shrivelling which was deterring buyers from purchasing the fruit because they believed the fruit was deteriorating. This shrivel issue did not disappear as the vines got more mature so a decision was made to de-commercialise the variety. Growers were able to transfer across to the other Gold variety SunGold (Gold 3) which had shown strong resilience to Psa-V.

5.3.5 Variety Licenses

Since the commercialisation of Gold3, Gold9 and Green14 in June 2010, a total of 6,800 hectares of licenced varieties have been allocated to New Zealand kiwifruit growers. This total includes 6,500 hectares of Gold3 and 300 hectares of Green14 although planted hectares of Green14 has declined and is currently less than 100 hectares. Approximately 60% (1,500 growers) of New Zealand growers grow at least one or more of Zespri's licenced varieties on a kiwifruit property that they own, totalling 1,950 orchards that grow a licenced variety. **All growers that grow a Zespri licenced variety are bound by a Zespri Kiwifruit Variety Licence which gives growers the right to acquire plant material for growing a variety within the licenced area.**

Zespri Variety Licenses – SunGold Licence Release

Significant investment is made by Zespri into a breeding programme that focusses on increasing returns to growers through the development of profitable new cultivars. Showing early signs of tolerance to Psa, there has been two licence release rounds for the SunGold Variety. Of the total licenced Gold3 area of 6,500 hectares, approximately 3,200 relate to a straight swap out of Hort16A or Gold9 when Psa hit. The remaining licenced area relates to earlier Fixed Price Bid licence releases (1,300 hectares) and the remainder is due to Closed Tender Bid allocations and entitlements owing to Pre-Commercial Trial growers. The Zespri Board has signalled that an additional 750 hectares of Gold3 will be released per year from 2019 to 2022 provided sufficient demand continues to exist and the variety performs in terms of taste requirements. This allocation is reviewed by the Zespri Board at the completion of each selling season.

5.4 ORCHARD ACCOUNTING 101

Monitoring of Kiwifruit Orchard Profitability

The reporting of profitability is an important task when monitoring the performance of an orchard. Growers give much time and thought into delivering quality crops ready for international markets. There are numerous orcharding activities that give rise to both income and costs on an orchard. The net position of income less costs equates to orchard profitability. Growers regularly review this equation to ensure their efforts are being rewarded financially.

In this section, there are four key areas that will be covered:

- Seasonal Timing of Orchard Income and Costs (Section 5.4.1)
- The Concept of Orchard Gate Return (Section 5.4.2)
- Orchard Financial Reporting (Section 5.4.3)
- Collection of Financial Data (Section 5.4.4)

5.4.1 Seasonal Timing of Orchard Income and Costs

The orcharding cash cycle of setting an orchard crop 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 via a series of functions and intermediaries. Final Net Income is not received by the grower until June of the year following harvest.

5.4.2 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 along the way such as freight charges, commissions, certain taxes, packing, coolstorage etc.

These costs and incentives are outlined in the contractual arrangement a grower has with their postharvest partner and in the Supply Agreement signed by Registered Suppliers and Zespri. The preferred format for growers reporting Orchard Gate Return for a full year is below. It is noteworthy to mention that Orchard Gate Return is not the complete measurement of orchard profitability, as it does not take into consideration orcharding costs such as pruning, pollination, fertiliser etc.

Orchard Gate Return

	2018 Harvest (\$ are for example only)
Income From Zespri	
Zespri Fruit Return	63,500
Plus Taste Income	3,000
Plus Early Start Income	14,400
Plus Loyalty Income	3,000
Total Income from Zespri	83,900
Cost of Post-Harvest	
Time Incentive Income	18,480
Less Fruit Loss Costs	(3,480)
Less Time Costs	(6,300)
Plus/Less Intercheck	(360)
Net Time Incentive	8,340
Less Packing & Harvest Costs	(21,900)
Less Coolstore Costs	(8,900)
Less Logistics Costs	(1,560)
Less Other	(500)
Total Cost of Post-Harvest	24,520
Total Net Income (Orchard Gate Return)	\$59,380

Right: Table showing Orchard Gate Return for a full year

5.4.3 Orchard Financial Reporting

The preparation of an orchard profitability report is a tool a kiwifruit grower can use to measure the financial performance of an orchard. It also forms part of the analysis in which to measure the financial viability of that orchard against an expectation or financial objective. The table on the following page provides an example 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 the set up a new overhead artificial canopy. Typically, such a report is reviewed on a monthly and annual basis.

The table on the following page includes columns for each month that Net Income (OGR) is received. The final column is a conversion of 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.

5.4.4 Collection of Financial Data

Collating this data into a user-friendly format should be kept simple and made readily available. There are a variety of means available to a grower to prepare such a report and it is often prepared with support from the growers 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.

KEY INPUTS
CANHA F/VINES M/VINES
1.20

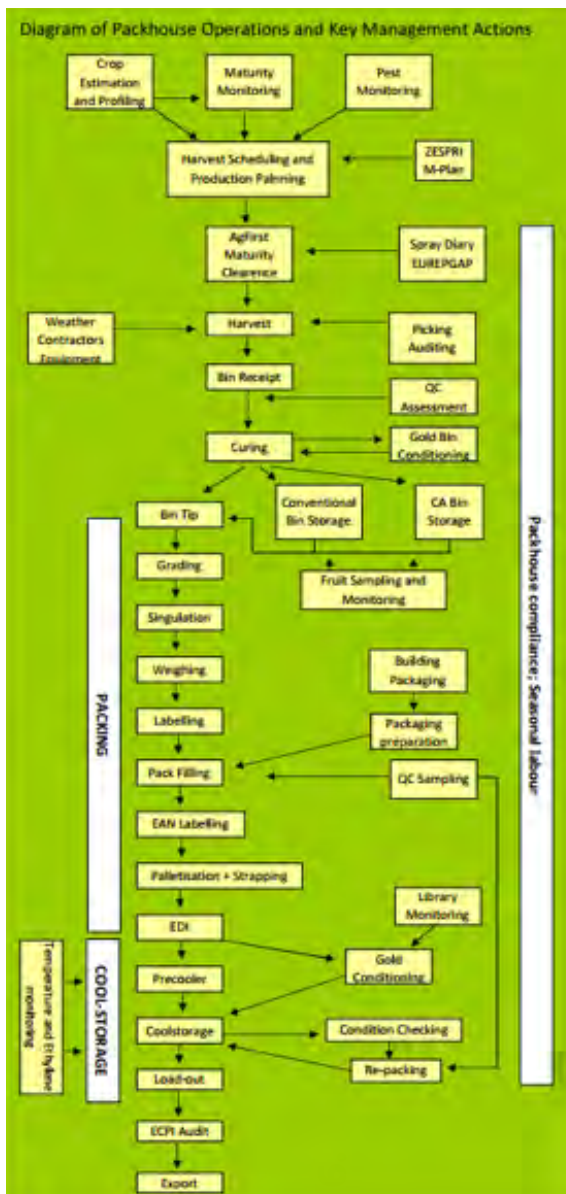
(NUMBERS ARE FOR EXAMPLE ONLY)

KIMBOP ORCHARD
- KIWIFRUIT ORCHARD PROFITABILITY
KPIN: 2175
LOCATION: PLUMMERS POINT ROAD
HARVEST YEAR: 2016
VARIETY: HAYWARD

	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Total	Per CANHA
Net Income																	
Net fruit payments (Orchard Gate Return)	562	4,425	5,210	2,509	4,310	5,980	7,020	11,411	3,169	1,027	4,554	2,369	2,061	2,369	1,776	50,380	49,483
ORCHARD COSTS																	
Harvesting costs		2,500	1,500													4,000	3,333
Orchard Production																	
Winter pruning				6,360												6,360	5,300
Male pruning								2,200								2,200	1,833
Summer pruning							750			1,200	1,500					3,450	2,875
Thinning										500		4,500				5,000	4,167
Girdling									250							250	417
Spraying (materials & application)																	
Fertiliser (materials & application)					2,800			3,200								6,000	5,000
Weed control (materials & application)								500		500						1,000	833
Pest monitoring										250						250	208
Soil test/leaf samples			750													750	625
Pollination								2,150								2,150	1,792
Mowing & Mulching																	
Shelter trimming					3,500											3,500	2,917
Global gap/compliance										250						250	208
Repairs & maintenance																	
Management																	
Total orchard production	-	-	750	6,360	8,300	-	-	7,350	2,450	2,700	1,750	4,500	-	-	-	32,160	26,800
Net Profit from Orcharding	562	1,925	2,960	-3,851	-1,960	5,980	7,020	4,061	719	-1,673	2,804	-2,131	2,061	2,369	1,776	25,220	16,350
Capital expenditure					5,500											5,500	
NET CASH INFLOW/(OUTFLOW)	\$562	\$1,925	\$2,960	-\$3,851	-\$7,460	\$5,980	\$7,020	\$4,061	\$719	-\$1,673	\$2,804	-\$2,131	\$2,061	\$2,369	\$1,776	\$17,720	
YTD NET CASH INFLOW/(OUTFLOW)	\$562	\$2,517	\$5,477	\$1,625	-\$5,865	-\$185	\$6,834	\$10,896	\$11,815	\$9,041	\$12,746	\$10,814	\$13,575	\$15,944	\$17,720	\$17,720	

6

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:

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6.1 HARVEST

Before fruit is harvested, it must be mature enough to ripen when it is off the kiwifruit vine. The fruit needs to meet the minimum dry matter threshold, be the right colour (Gold3 and Green14 only), reach the minimum Soluble Solid Concentration (SSC) or brix

(sugar content of an aqueous solution), and have sufficient black seeds (Hayward and Green14 only). 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.

Right:
Sampler collecting a maturity sample



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 means tasty fruit.

Right:
Fruit slices after being dried in a dehydrator



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.

Right:
Dry matter accumulation
graph from a maturity report



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.

Right:
Brix accumulation
graph from a maturity report



Generally, kiwifruit harvest begins in March. 'Mainpack' for Hayward is in May which is when the majority of fruit is harvested. Gold varieties 'Mainpack' is generally a little earlier. Harvest is generally over by the middle of June. There are two types of additional payments growers receive based on when their fruit is shipped. These are called the Kiwistart Premium and Time Payments. This section will describe the harvest timings for two different cultivars, the timing of harvest between regions, and the Kiwistart Premium and Time Payments.

6.1.1 Timing

The 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. Gold kiwifruit harvest starts in mid to late March and is normally complete by early May. Poverty Bay, Hawkes Bay and coastal Bay of Plenty are usually harvested ahead of other regions.

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 plus a 15% premium. 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

Below:
Kiwifruit passing over grading tables in the packhouse.

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

A packhouse operator receives fruit from the kiwifruit orchard in bins and places the fruit into packs before putting them into storage in preparation for shipping. 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 46 packing facilities and 95+ 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 up to 15 million trays per season.



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. 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. For more information on GAP, see Chapter 8.3.

Right:
Zespri Kiwifruit exported to South Korea in loose modular bulk pack and re-packaged in smaller retail packs
(Mark Gardiner, Nov 2014)

6.2.2 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 also used to meet customer requirements where fruit transferred from loose filled bulk packs and packed 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.



6.2.3 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 either contain 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.

Another example of specific packaging requirements is when Zespri Organic Kiwifruit is exported to Japan. Zespri Organic Kiwifruit is packed into a standard Green Modular Bulk (MB) pack and an organic coupon label is applied to the end panel of the pack. If the product is fumigated, the top layer of the label is removed, and it changes the descriptor to Green Kiwifruit – whereas previously it said Organic Green. Zespri are also required to have the Japanese Agricultural Standard (JAS) organic certification logo on any organic packs exported to Japan.

Right:
Zespri Green Organic Green Kiwifruit label which is then removed if required (i.e. fumigation) to reveal the standard

Far right:
Green Kiwifruit label



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.

“ 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. ”

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.

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 3,000-6,000 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. Reefer ships offer the advantages of quick direct transit times, ability to condition (ready to eat) fruit whilst transiting to a destination and allow large volumes of fruit to be delivered to markets.

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 its 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 2018, it is estimated Zespri will ship globally from New Zealand over 17,000 FEU (349,000 pallets) on containerised liner services and charter some 46 reefer ships carrying over 222,000 pallets.

Right:
A typical container ship





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

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7.1 TECHNOLOGY

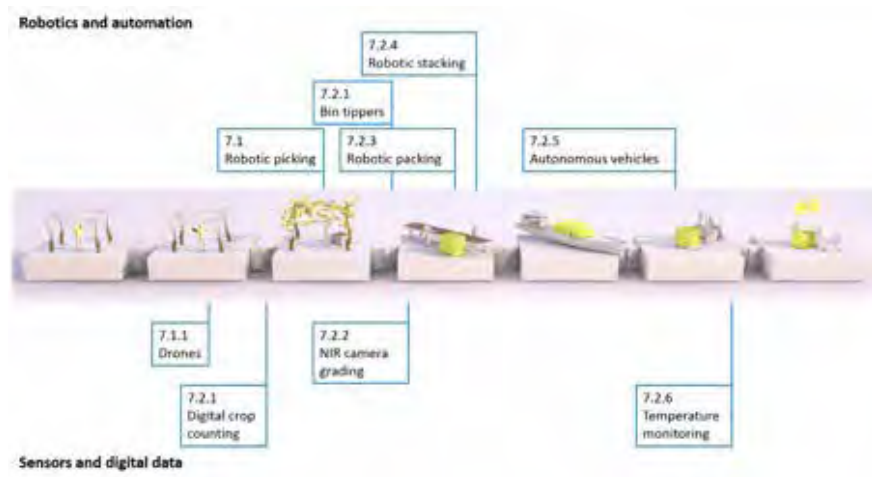
While technology has always been an important part of the horticulture industry, it is becoming increasingly so. Technology can come in several forms: Robotics and automation are usually introduced in horticulture to drive efficiencies in tasks typically requiring human labour that are either dangerous, 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 in the Bay of Plenty alone requires an additional 14,329 people by 2030 in order to harvest and pack the crop 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.

Right:

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



7.2 ON THE ORCHARD

Orchard operations require a lot of labour to maintain. One key activity in the field is harvesting and without labour to help pick the fruit, orchardists could face the threat of their crops rotting on the vine. While there are many different ideas on how harvesting may be automated, the robotic harvesting of kiwifruit is one area that has come a long way in recent years. As robotic harvesters can work night or day without the provisions that traditional labour requires, this technology may become increasingly utilised on orchards in the long term.

Right:
Robotics Plus robotic kiwifruit
harvesting autonomous
vehicle



7.2.1 Drones, GPS Units and GIS Software

On the orchard, UAV (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 pre-programmed to follow a flight path and undertake functions using GPS.

Zespri's use of Drones, GPS Units and GIS Software

All orchards that are allocated a PVR'd variety (Zespri Plant Variety Rights) are subject to an audit by Zespri upon grafting or planting the licenced fruit.

These orchards may also receive random audits over the lifetime of the PVR or when a change to the licenced orchard area has occurred. Zespri contracts GPS-it Limited www.gpsit.co.nz to undertake all of the GPS mapping for PVR'd varieties.

GPS-it has carried out the PVR audit programme since its' beginning in 1999. The programme has been improved and refined over time in response to technology and industry changes. The three main technologies used are:

- High accuracy GPS units;
- Drones (UAV) used to capture aerial imagery; and,
- 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 becoming more commercially popular and GIS software being 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.

“The accuracy and reliability of GPS units has improved along with an increased number of available satellites, UAV's becoming more commercially popular and GIS software being much more accessible and user-friendly.”

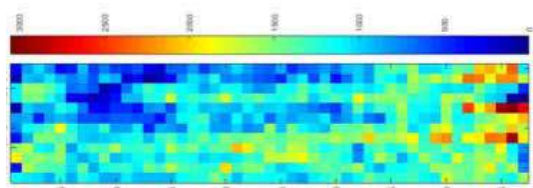
7.2.2 Digital Crop Counting Technologies

An area of rapid technology development that is close to commercialisation for use by kiwifruit growers is the use of ground based camera imaging systems. 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 from leaves when viewed from above, for example from a drone. Zespri has directly invested in digital crop counting technologies, and a number of other parties are also looking to develop solutions for the industry.

A combination of technologies is reaching the point where they are enabling unprecedented levels of accuracy in counts, and thus

information available to the industry to make informed decisions. For a kiwifruit grower, this information (for example a fruit count early in the season) enables them to make informed decisions about their crop management throughout the season to maximise their orchard performance. The same information is of high value to the postharvest suppliers for all manner of operational planning (eg. Do we have enough coolstore space? How much harvest labour will require?). This same information again is of high value to Zespri to assist its planning of the coming fruit supply season from New Zealand. Knowing the volume of fruit Zespri has to sell in any season in good time enables Zespri to maximise returns to its growers.

Right:
A visualisation from part of a Zespri Gold3 growers 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 fruit have been tracked and counted!



7.3 POSTHARVEST OPERATIONS

In the postharvest world, there is also a large amount of labour required to grade and pack the fruit into export pallets of product ready to ship around the world.

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

7.3.1 Bin Tippers

Firstly, once the bins of fruit arrive from the orchard at the packhouse, the bins of fruit must be emptied into the grading and packing line. The technology that assists with this activity is an automated bin tipper.



7.3.2 Near Infrared Camera Grading

Once on the grading line, the latest technology currently being used in the industry is called Near Infrared (NIR) Camera Grading. This technology takes thousands of images of the individual fruit and makes decisions about its size and quality. The model 'Spectrim' is the latest optical sorting technology available in the kiwifruit industry. <http://www.compacsort.com/en/inspectra2/>

Right:
NIR grading machine



How does NIR work?

How the NIR cameras work is that they pulse light into fruit and measure changes in wavelengths in rebounded light. NIR can measure the internal qualities of fruit including; dry matter, brix, colour, and pressure. 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 across multiple wavelengths to identify internal and external fruit defects, including; blemishes, flat fruit, soft fruit, and sooty mould.

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.

Measuring Quality and Standards

The primary 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 2018 was >70% of fruit sampled met a Dry Matter (DM) level of 16.1% or greater.

Small count sizes generally have lower dry matter and it isn't uncommon for smaller size counts i.e. 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 chromometre. 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.

Storage Benefits

Another bonus with NIR technology is that it has the potential to see inside the fruit and 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.

“ Another bonus with NIR technology is that it can also see inside the fruit and 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? ”

7.3.3 Robotic Packing

After grading, the fruit need to be placed in trays. Due to the need to place the fruit quite precisely, this has traditionally been a very labour-intensive exercise. Technology is being deployed in different areas of horticulture currently that is removing labour from this process, as seen below with the Robotics Plus apple packing robot.

<http://www.scoop.co.nz/stories/BU1805/S00303/robotics-plus-signs-global-deal-for-robotic-apple-packers.htm>

Right:
Robotics Plus apple packing robot, is this the next step for the kiwifruit industry?



7.3.4 Robotic Stacking

After grading and being placed into their trays, the fruit then need to be assembled onto pallets and strapped down ready for shipping before they can be put into cool storage. This area is being quickly automated also with what is called palletisation and it is possible already to do this completely without human interference.

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



7.3.5 Autonomous Vehicles

Forklifts require labour for operation. 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.

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



7.3.6 Temperature Monitoring and Management of Fruit from Coolstore to Market

Much of New Zealand’s fruit travels from New Zealand to northern hemisphere markets. 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.



7.4 FUTURE AUTOMATION

Currently EastPack based in the Bay of Plenty is developing the industry's first 'lights out' coolstore. This means the internal operations of the coolstore operates automatically without humans or forklifts entering the store. A gantry delivers and retrieves fruit to

racks which have automatic shuttles which deliver pallets to their final position in the store. This allows; space utilisation, air flow accuracy, energy efficiency and will ultimately benefit the shelf-life of the fruit.



CHAPTER EIGHT PEOPLE

It is estimated the industry will need another 7,000 seasonal employees in order to reach its growth targets of 190 million trays by 2027. 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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8.3	Certification for GlobalG.A.P. and GRASP	121



8.1 LABOUR

Employment Statistics

A 2017 NZKGI survey found there are 15,678 seasonal workers employed in the kiwifruit industry which is forecast to expand to 22,699 people by 2027. As the kiwifruit industry strives to take advantage of increased global demand, shortages of seasonal labour will be a challenge for the kiwifruit industry. To read more on the shortage of seasonal labour, read the NZKGI 2018 Seasonal Labour Report on the NZKGI website at www.nzkgi.org.nz/nzkgi-labour-shortage-report/.

Current estimations state 10,000 people are placed in year-round employment in the kiwifruit industry. This number will be updated after a NZKGI-led analysis in 2019.

RSE Workers

The Recognised Seasonal Employer (RSE) scheme came into effect in April 2007. The policy currently 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 RSE has led to increased demand from employers and the cap was increased to 11,100 in December 2017. Unless employers can show they have pre-established 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.

Right:
In 2019 there will be 12,850
RSE workers coming to
New Zealand



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 by at least 25 percent by 2020. The new 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-and-industry/horticulture/keep-safe-keep-growing-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:

www.nzkgi.org.nz/health-safety-pcbu/

Health & Safety Software Options Comparison Table

To help growers understand the various health & safety systems available, NZKGI engaged BECA to complete a review of 12 health & safety software products currently available in New Zealand. This review has been completed against a set of requirements identified by kiwifruit industry representatives and has been collated into a comparison table available. The comparison table is located on the NZKGI website at

<https://nzkgi.org.nz/health-safety-software-options-comparison-table/#article>

A specific recommendation has not been made as to which product should be used and this is intended to be a tool to help inform kiwifruit growers in their decision making should they choose to utilise a health and safety software system.

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

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 GLOBAL G.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 GAP compliance. Growers are required to ensure that everyone working on the orchard is compliant with the GAP requirements at all times.

For GAP purposes, a contractor is defined as anyone hired by to undertake work that is addressed by one or more requirements in the GAP 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 contractors responsibility to ensure that all requirements as set by legislation are met, specifically in regards 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
5. That workers have signed contracts
6. That there are regular payments of employees' wages
7. Payment of at least national minimum wages or according to bargaining agreement
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

A career in horticulture isn't just about picking and packing fruit; there are many highly-valued roles available in the scientific, commercial and technical sectors. This chapter includes a career map displaying the wide range of career opportunities available, and provides biographies of industry entrants to show the pathways they took to get where they are today.

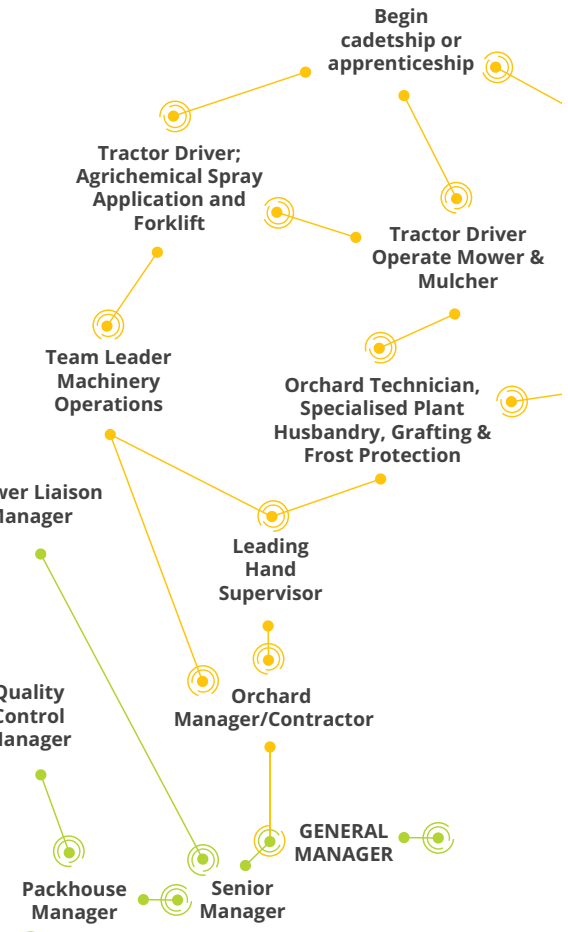
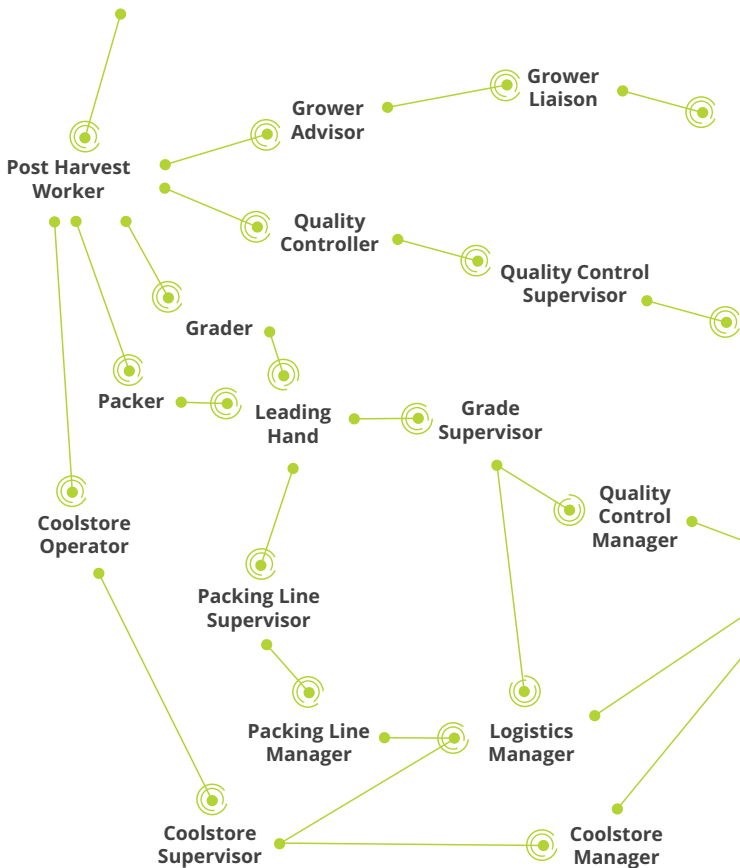
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9.1 HORTICULTURE CAREER PATHWAYS

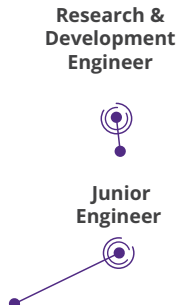


START HERE FOR A POST HARVEST CAREER



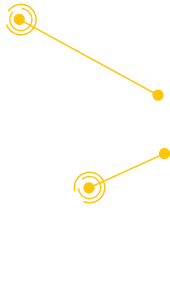
START HERE FOR AN ENGINEERING CAREER

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

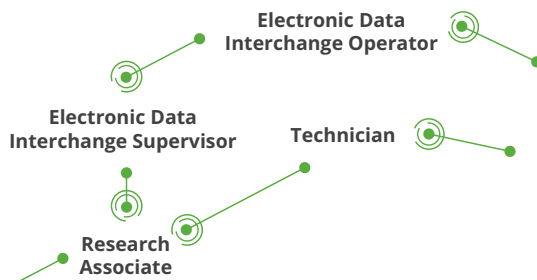




START HERE FOR AN ORCHARD CAREER



Orchard Worker
- Harvesting,
Plant Care and
Construction

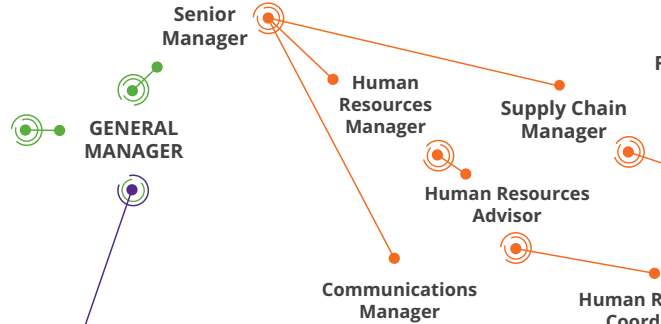


START HERE FOR A SCIENCE CAREER

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

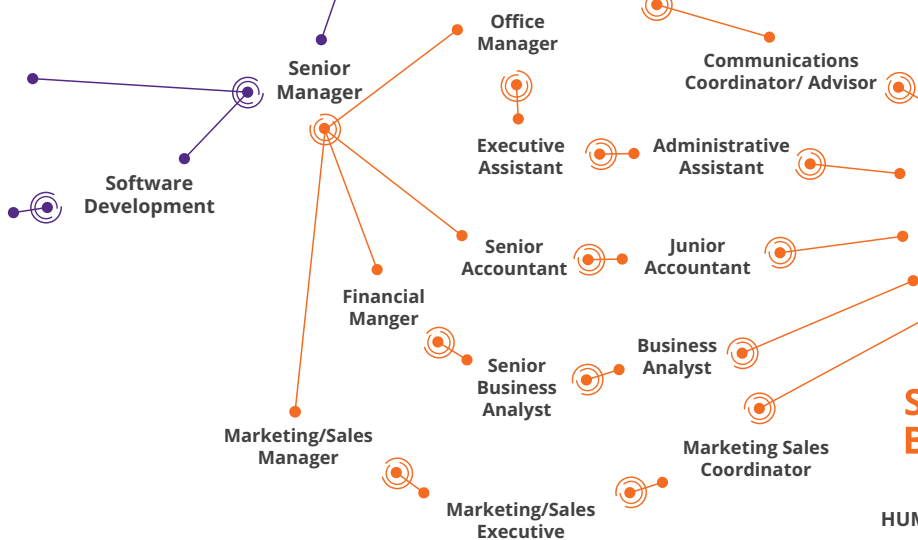


GROWER DIRECTOR CEO

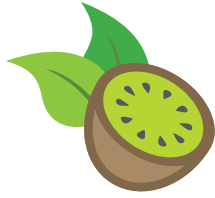


START HERE FOR A BUSINESS CAREER

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

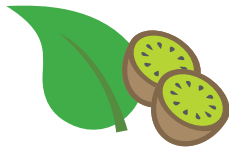


As indicated in the horticulture career map on the previous page, there are a number of ways to enter the industry whether it be through direct employment, part time study and employment, or full-time study.



Full-Time 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 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. There are study options to suit everyone from Level 1 Horticulture through to apprenticeships.



Full-Time Study

Study a range of subjects such as business, engineering, science and horticulture all of which are applicable to a career in the kiwifruit industry.

The next page will provide career profiles of people who have entered the kiwifruit industry by way of full-time study, part-time study/employment and direct employment.



9.2 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

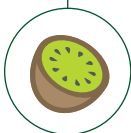


HIRAINA TANGIORA

Role/Organisation: **External Relations Coordinator at Zespri**

Pathway: **University Degree**

I love working in the Kiwifruit industry as it is full of passionate, creative and intelligent people all working collaboratively to achieve the same goal. Due to the variable nature of kiwifruit, you must constantly think on your feet and be highly adaptive to changes; however, it means no two days are the same and provides a great amount of variety and diversity. I encourage anyone looking for a fulfilling career to consider the kiwifruit industry- there is more to the industry than meets the eye!



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.

9.3 '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

	2017/18	2016/17	2015/16	2014/15	2013/14	2012/13	2011/12	2010/11
Distribution to growers/suppliers								
Fruit and service payments (excl loyalty premium)	11.53	9.21	9.27	9.57	9.02	9.08	8.37	8.44
Loyalty premium	0.27	0.25	0.24	0.24	0.24	0.24	0.24	0.24
Total payments per tray	11.80	9.46	9.51	9.81	9.26	9.32	8.61	8.68
Crop volumes (000's)								
Trays submitted (gross)	125,822	148,902	123,763	97,304	87,725	105,580	119,444	105,868
Trays supplied	124,433	145,871	120,145	95,683	86,510	102,860	113,932	101,712
Trays sold	123,246	137,748	117,094	95,187	86,094	101,313	109,129	98,117
Trays sold as a percentage of trays supplied	99.0%	94.4%	97.5%	99.5%	99.5%	98.5%	95.8%	96.5%
General statistics								
Production per hectare (trays submitted)	9,913	11,838	10,157	8,662	8,016	8,610	9,556	8,255
Producing hectares	12,692	12,578	12,185	11,233	10,944	12,263	12,500	12,825
Orchard Gate Return per hectare (average)	79,361	68,868	60,758	57,369	49,385	51,153	45,206	41,830
Number of producers	2,405	2,435	2,156	2,540	2,350	2,636	2,662	2,706
Average number of trays supplied per producer	51,739	59,906	47,752	37,670	36,813	39,021	42,799	37,588
Number of orchards registered								
0 – 2 hectares	774	791	807	834	802	855	913	867
2 – 5 hectares	1,509	1,508	1,499	1,428	1,458	1,483	1,521	1,512
5 – 10 hectares	607	589	568	515	487	573	577	602
Over 10 hectares	165	161	147	128	126	146	138	153
Total (KPINS)	3,055	3,049	3,021	2,905	2,873	3,057	3,149	3,134

	2017/18	2016/17	Variance
Zespri global kiwifruit sales	\$2.391 billion	\$2.262 billion	6%
Export earnings (New Zealand grown)	\$1.708 billion	\$1.603 billion	7%
New Zealand-grown fruit and service payments	\$1,468.1 million	\$1,380.0 million	6%
New Zealand-grown Orchard Gate Return (OGR) per hectare	\$79,361 (average)	\$68,868 (average)	15%
- Green	\$59,981	\$53,555	12%
- Organic Green	\$52,375	\$54,427	-4%
- Gold	\$114,345	\$98,838	12%
- Green14	\$38,937	\$45,853	-15%
Zespri global volume (trays sold)	138.6 million	154.3 million	-10%
New Zealand-grown	123.2 million	137.7 million	-11%
Non-New Zealand-grown	15.4 million	16.6 million	-7%

Key figures from Zespri's Annual Results 2017-18

NEW ZEALAND INDUSTRY PERFORMANCE

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

	2017/18		2016/17		2015/16		2014/15	
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	109	5,779	113	9,559	116	7,666	124	7,852
Auckland	273	7,719	272	9,502	273	8,099	304	8,805
Bay of Plenty								
Katikati	940	7,678	966	11,972	973	9,748	1,015	9,224
Opotiki	457	8,917	464	11,758	469	10,756	477	9,691
Tauranga	1,086	9,193	1,116	12,533	1,090	10,135	1,109	9,295
Te Puke	3,419	9,641	3,508	13,088	3,524	12,204	3,586	9,486
Waihi	100	6,569	100	8,701	105	7,604	115	6,957
Whakatane	402	7,728	439	9,889	438	8,248	466	4,840
Waikato	200	8,339	204	9,664	206	8,867	209	7,462
Poverty Bay	54	8,366	54	5,828	55	6,605	59	5,558
Hawkes Bay	43	6,620	45	7,290	47	8,265	51	7,554
Lower North Island	70	8,696	65	7,056	69	6,186	70	7,750
South Island	229	5,663	258	7,246	250	6,158	309	5,591
Total producing hectares	7,382		7,604	-	7,614	-	7,892	-
Average TE supplied per hectare		8,812	-	11,933	-	10,590	-	8,812

	2017/18		2016/17		2015/16		2014/15	
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 Organic Green Kiwifruit								
Northland	-	-	-	-	-	-	3	2,473
Auckland	1	2,614	1	5,856	1	3,983	1	4,376
Bay of Plenty								
Kaikōura	30	6,593	31	9,208	30	8,037	31	7,274
Otago	22	5,786	22	8,616	22	7,404	22	7,407
Tairāpiti	203	6,033	210	8,652	231	8,054	261	5,994
Te Puke	42	6,979	38	10,408	57	8,841	77	6,953
Waikato	19	3,964	20	4,219	20	4,808	20	4,099
Whakatane	4	4,197	4	5,323	3	5,171	3	1,834
Waikato	151	5,310	151	6,536	153	6,148	156	5,428
Poverty Bay	1	3,676	2	4,637	2	5,284	3	5,817
Hawkes Bay	-	-	-	-	-	-	-	-
Lower North Island	2	5,552	2	6,524	2	6,365	2	6,533
South Island	-	-	21	4,516	16	2,873	19	3,593
Total producing hectares	475		502	-	537	-	597	-
Average TE supplied per hectare		8,812	-	7,841	-	7,254	-	5,908

	2017/18		2016/17		2015/16		2014/15	
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 Gold and Organic Gold Kiwifruit (Hort 16A)								
Northland	11	8,615	52	12,721	172	12,133	213	14,522
Auckland	-	-	1	5,822	15	12,969	38	11,327
Bay of Plenty								
Kaikōura	-	-	-	-	1	10,618	10	8,975
Otago	-	-	-	-	-	-	12	3,730
Tairāpapa	-	-	-	-	1	4,712	5	4,249
Waikato	-	-	-	-	1	13,777	3	6,706
Whānau	-	-	-	-	-	-	-	-
Waikato	-	-	1	9,394	15	8,802	31	7,931
Pōhā	-	-	48	9,245	69	8,365	105	8,251
Hawke's Bay	2	7,793	12	11,484	55	11,667	67	13,722
Lower North Island	-	-	-	-	-	-	-	-
South Island	17	10,647	47	9,349	64	10,796	71	9,853
Total producing hectares	30		161	-	394	-	555	-
Average TE supplied per hectare		9,689	-	10,561	-	11,077	-	11,586

	2017/18		2016/17		2015/16		2014/15	
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 and Organic SunGold (Gold3)								
Northland	319	8,044	189	9,069	122	6,104	62	5,585
Auckland	206	10,701	187	8,928	139	5,694	48	7,688
Bay of Plenty								
Katikati	525	11,299	501	12,302	423	7,521	205	7,416
Opotiki	506	12,172	478	11,028	403	8,298	213	5,041
Tauranga	437	12,320	413	12,484	7	8,073	195	6,229
Te Puke	1,655	12,390	1,516	12,746	1,262	9,220	786	4,702
Waihi	53	9,168	51	11,027	43	8,828	26	5,065
Whakatane	211	13,211	206	11,175	167	8,861	101	6,514
Waikato	183	7,937	157	7,029	125	3,295	26	2,966
Poverty Bay	208	9,740	146	8,728	103	8,586	62	8,826
Hawkes Bay	149	8,263	131	6,815	80	9,562	52	10,865
Lower North Island	2	7,799	2	5,349	1	5,227	1	4,436
South Island	176	8,693	139	9,635	103	8,758	37	7,124
Total producing hectares	4,630		4,116	-	3,339	-	1,814	-
Average TE supplied per hectare		11,292	-	11,366	-	8,234	-	5,770

	2017/18		2016/17		2015/16		2014/15	
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	3,401	1	7,210	1	4,243	1	3,611
Auckland	14	5,238	14	6,256	13	5,336	13	4,576
Bay of Plenty								
Katikati	11	7,377	15	8,571	16	6,331	17	3,928
Opotiki	12	7,790	14	9,758	18	6,507	19	3,848
Tauranga	6	5,845	8	6,899	10	5,892	12	5,180
Te Puke	80	7,711	88	9,148	115	6,564	106	3,813
Waihi	-	-	-	-	-	-	1	8,270
Whakatane	18	7,550	20	5,984	15	4,960	19	3,792
Waikato	15	5,428	18	5,686	16	3,175	17	2,743
Poverty Bay	4	6,985	4	6,072	4	6,888	4	4,640
Hawkes Bay	8	4,415	8	4,363	8	8,358	8	7,969
Lower North Island	4	6,486	4	3,679	4	5,505	4	2,800
South Island	2	2,789	1	6,506	1	5,280	2	3,700
Total producing hectares	175		195	-	223	-	223	-
Average TE supplied per hectare		6,925	-	7,813	-	6,109	-	4,020

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

