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Economic Implications of Greenhouse Gas Emission Reduction in the New Zealand Kiwifruit Supply Chain: An Eco-Efficiency Perspective

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Oliver Hoare

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Executive Summary

The New Zealand kiwifruit supply chain is faced with the complex challenge of reducing greenhouse gas emissions while continuing to grow economic value in new and existing markets around the world. As the focus on climate change continues to intensify, New Zealand grown kiwifruit must demonstrate a willingness to adapt to maintain market share and international market access.

The main objective of the report was to investigate both the current and future emission reduction efforts in the New Zealand Kiwifruit supply chain. Further, the report also sought to analyse the economic implications of implementing these emission reduction efforts. The intersection of emissions reduction and economic consequences is of significance as it demonstrates how efforts to combat global warming can lead to financial well-being and security for those involved in the industry.

Further, this report aimed to provide an objective evaluation of the global market for kiwifruit grown in New Zealand, and to outline the potential outcomes of either reducing or not reducing emissions throughout the supply chain. The scope of the report was limited to the four key segments of the supply chain within New Zealand's jurisdiction: kiwifruit growers, post-harvest operations, Zespri, and shipping.

The methodology of the report included a literature review, seven key interviews with sustainability staff, kiwifruit growers, and government officials, and then a thematic analysis guided by the overarching principle of triangulation. The literature review provided context around the reasons and methods of emission reduction, as well as outlining the metric of eco-efficiency and what this means. Semi structured, qualitative interviews played an important role in providing insight into the emissions reduction efforts and economic effects. The use of triangulation methodology enhanced the validity of the results and ultimately produced a more credible set of findings.

Key Findings

- Emission reduction activities are already taking place throughout the supply chain. For example, reducing fossil fuel use, fertiliser and compost use, effective waste management, installing solar power, refrigerant management, electrification, investment into technology, scope 3 influence among others. These have varying levels of success, and it isn't always clear what the economic implications are.
- General consensus among interviewees found that emissions need to be reduced, however there is a lack of clarity regarding process and economic implications. This particularly applies to kiwifruit growers as part of the carbon neutral trial, but also for post-harvest facilities implementing emission reduction initiatives.
- Eco-efficiency is an important metric when measuring the convergence of emission reduction and economic value. One of the advantages is it can be standardised across the entire supply chain and used as a collaboration tool.

- International Trade Agreements showed a strong increase in demand for reduced embedded carbon in produce out of New Zealand. In the European Union's case, New Zealand products must meet Paris Climate Accord obligations by 2030 or risk losing this market.
- Economic analysis yielded insight into current emission reduction activities and their economic impact, cost and payoffs. An example is the investment in electric vehicles for post-harvest facilities. Although costly up front and dependent on the electricity source, the cost-savings can be high and the payoff scope very low.
- Further research and investment into green shipping is necessary, given kiwifruit and New Zealand's primary exports rely on maritime transport.

Recommendations

- Industry Advisory Council (IAC) to introduce eco-efficiency as a standard measure of emission reduction efficacy across the kiwifruit supply chain in the next five years.
- Zespri to adjust the Carbon Neutral Trial to provide participants with more information on future direction as well as economic benefits and drawbacks. Zespri to encourage collaboration among participants.
- Zespri, in conjunction with Ministry of Foreign Affairs and Trade as well as Ministry of Primary Industries to create a 'Green Shipping Council' in New Zealand, to proactively manage the rapidly evolving shipping environment.
- Kiwifruit stakeholders and New Zealand trade experts to advocate internationally for efforts aimed at reducing greenhouse gas emissions in the kiwifruit industry.

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1. Introduction

The New Zealand kiwifruit supply chain is adapting to a shifting global environment as it grapples with the convergence of emission reduction and economic prosperity. With growing focus on issues like climate change, there is increased pressure on food production around the world to minimise greenhouse gas emissions and ensure long-term sustainability.

This report explores the New Zealand kiwifruit supply chain, with an emphasis on emission reduction and its economic implications. The report investigates four key segments of the supply chain: kiwifruit growers, post-harvest packing facilities, Zespri, and the shipping environment. Each of these segments presents different challenges in balancing economic competitiveness with emissions reduction, essential for accessing global markets and continued growth.

New Zealand's domestically grown kiwifruit enjoys several advantages when competing globally in the agricultural sector. Firstly, the industry maintains a relatively low carbon footprint, owing to the nature of horticulture and its relatively modest input requirements compared to other farming activities. Moreover, kiwifruit aligns well with New Zealand's "clean and green" image and is widely perceived as a healthy, environmentally friendly product in international markets (Kenny, 2008). Since the market for kiwifruit is comparatively small on a global scale, it faces fewer significant protectionist barriers, as only a handful of countries commercially grow and sell the product.

Despite these inherent advantages, the kiwifruit category must adapt to remain internationally competitive as the world increasingly confronts climate change issues. Some of the primary challenges in transitioning to a low-emission production model include dealing with the considerable distance from major markets, addressing embedded carbon in various stages of the supply chain, and reimagining traditional growing, transportation, and packing methods, which often carry high carbon footprints.

This report assesses these four fundamental aspects of the supply chain from both an emissions reduction and economic viability perspective. The overall goal is to contribute to the ongoing progress of the kiwifruit category within an evolving global landscape.

2. Project Scope and Objectives

The challenge of emission reduction spans across various phases of the supply chain, encompassing both onshore and offshore operations. The need for international shipping to transport kiwifruit to distant markets, including Europe, China, and the USA, adds another layer of complexity to emission reduction. This report analyses multiple areas; firstly, to conduct a critical analysis of the opportunities for greenhouse gas (GHG) reduction within New Zealand's kiwifruit supply chain, identifying the most effective methods to achieve this goal. Secondly, it aims to assess the economic implications of implementing these emission reduction measures throughout each segment.

The project distinguishes key areas of the New Zealand kiwifruit supply chain:

Growers: This segment is fundamental to the supply chain, and the report dissects the year-round processes on a typical kiwifruit orchard concerning GHG reduction. The analysis extends to aspects such as fertiliser usage, machinery operation, water consumption, and other inputs necessary for growing export-grade kiwifruit in New Zealand (Zespri, 2020). Importantly, it explores the challenges faced by kiwifruit orchardists in adopting low emission growing practices and highlights the economic opportunities available to them. As growers have substantial influence over the entire supply chain, this section plays a pivotal role in the broader context.

Post-harvest (packhouse): With approximately 53 packhouses in operation, these facilities serve as critical components of the kiwifruit supply chain, responsible for packing, storing, and dispatching fruit (NZKGI, n.d.) The impact of packhouses on the industry is not limited to their operational role but also extends to their capacity to advocate for and implement emission reduction measures. A central focus here is on the cool stores owned and operated by packhouses. Given kiwifruit's long storage ability, these cool stores remain operational for up to 9-10 months a year to allow the delivery of kiwifruit worldwide (NZKGI, 2022). The GHG impact of these cool stores is considerable, particularly from refrigerant leaks, and transport and logistics also play a role. This section undertakes a critical analysis of post-harvest facilities from an emission reduction and economic viability perspective.

Zespri: The unique structure of the New Zealand kiwifruit industry as a regulated monopoly for exporting kiwifruit presents distinct opportunities and challenges in terms of mitigating climate risks and reducing environmental impact throughout the supply chain (NZKGI, n.d.).

Zespri aims to assist the entire industry in addressing these challenges while also addressing its own environmental footprint. A key challenge for Zespri is to persuade growers and packhouses to invest in emission reduction technologies and methods, given the financial constraints facing some stakeholders and the difficulty in displaying the benefits. Additionally, Zespri plays a pivotal role in innovation, managing an extensive cultivar program in collaboration with Plant and Food Research under the name of the Kiwifruit Breeding Centre (Plant and Food, 2021). This program holds the promise of developing cultivars that are more resilient to climate change and yield fruits of higher quality, taste, and storage characteristics. As the primary kiwifruit exporter from New Zealand, this report includes an extensive

section exploring Zespri's influence and potential for GHG reduction across the supply chain.

Shipping: International shipping is a vital component of the kiwifruit supply chain, serving as the primary mode of transporting New Zealand-grown kiwifruit to global markets. Given the significant distances to these markets, shipping accounts for a substantial portion of the emissions generated throughout the supply chain (Zespri, 2021). As per Zespri's five-year outlook, the volume of kiwifruit exported from New Zealand is projected to exceed 300 million trays by 2030, indicating an increased demand for shipping services (Zespri, 2022). The report highlights the significance of shipping companies in delivering premium kiwifruit to international markets and aims to identify areas within shipping that offer opportunities for GHG reduction to ensure long-term resilience in the supply chain.

Subsequently, the report examines the concept of eco-efficiency (EE) as a metric and its potential applications in the New Zealand kiwifruit supply chain. Several studies have been completed to illustrate how EE can identify decarbonisation opportunities that add economic value (Müller et al., 2014), however it has not yet been widely adopted. Holistically, the report aims to critically examine both the GHG reduction and economic opportunities within the New Zealand kiwifruit supply chain, within a wider context of the ongoing sustainability of the industry.

Photograph: istockphoto.com

3. Literature Review

3.1 Introduction

Conducting a literature review was essential in setting the broad context of the report, by thoroughly investigating a wide range of existing knowledge on this topic. The review produced results highlighting that there had already been considerable research into GHG emissions throughout supply chains, particularly in shipping and transport, but also specifically into emissions from growing kiwifruit in New Zealand. There has also been significant research completed on market led demand for cleaner fruit produce and the likes of 'carbon labels', which are seeing an increase throughout the world. By analysing a wide range of industry reports, peer-reviewed articles, and opinion pieces, the report was able to identify key themes in existing literature and where new research may be valuable.

3.2 Key themes

3.2.1 Energy use in the kiwifruit supply chain

The use of energy in the kiwifruit supply chain in New Zealand is a significant concern due to New Zealand's geographical isolation and the need to maintain proper storage conditions for extended periods. The literature review reveals that energy consumption is a recurring theme, with various studies highlighting the importance of prioritising emission reduction measures and improving energy efficiency.

McLaren et al. (2009) emphasise the need to reduce emissions in the kiwifruit supply chain. They identify key areas for emissions reduction, including cutting fuel and electricity consumption in orchard operations and implementing more energy-efficient practices in packhouses and cool stores. New Zealand's unique energy challenge arises from its heavily renewable electricity grid, with 80-85% renewable energy sources (GenLess, n.d.), in combination with a transport sector heavily reliant on fossil fuels as researched by Walmsley et al. (2015). The transition towards 100% renewable electricity offers potential emission reduction benefits for packhouses, offices, and electric vehicles.

Energy efficiency is a critical aspect of reducing emissions and improving sustainability in the kiwifruit supply chain. Rizet et al. (2012) conducted a study comparing carbon footprints and energy efficiency in competing supply chains across different countries, including France, Belgium, and the UK. The findings from this study are relevant to New Zealand's context, as these countries are key markets for Zespri branded kiwifruit, and their energy networks share similarities with New Zealand's.

The study revealed several important factors:

- Energy emissions vary among countries, influenced by factors such as energy sources and energy efficiency practices.
- Energy consumption and emissions at distribution facilities depend on the quality of the products transported.

- Energy consumption is influenced by variables such as distance, transport mode, load factors, and consumer density.

These findings underscore the importance of improving energy efficiency in the kiwifruit supply chain. The concept of energy efficiency is critical to this report as it applies across the entire supply chain and can be implemented as a measure to evaluate the economic opportunity to the kiwifruit industry.

3.2.2 Shipping as a large emission contributor

While analysing research and industry reports across the horticultural sector in New Zealand, shipping repeatedly presented itself as a large greenhouse gas emitting activity. In the New Zealand-grown kiwifruit supply chain, shipping accounts for 43% of total GHG emissions (Zespri, 2021). The Iriarte et al. (2021) study found that ocean freight contributed to 39.2% of overall emissions from the supply chain. This highlights a consistent theme among Southern Hemisphere producers, of having to ship our products large distances because many of our markets are in the Northern Hemisphere including Europe, Asia and North America. From a holistic point of view, New Zealand's economy is highly reliant on ocean freight, moving 99.5% of New Zealand's internationally traded products (Fitzgerald et al., 2011). This presents a significant risk moving into the future, as fossil fuel emissions become more scrutinised, and consumers demand cleaner products in the market (Müller et al., 2016).

3.2.3 Fertiliser used in growing kiwifruit

Fertiliser use in orchards in New Zealand reoccurred in the literature as a significant source of GHG emissions. Past research reports Müller et al. (2014, 2016) found that fertiliser use and nitrogen associated emissions were the leading causes of emissions in kiwifruit orchards in their studies. This came as no surprise, after the New Zealand Government introduced a cap on the use of synthetic nitrogen fertiliser of 190kg per hectare on any contiguous parcel of pastural land throughout the country (MPI, 2016). Although the introduction of the nitrogen (N) cap was partly due to nitrogen leaching into waterways, it was supported by evidence of GHG emissions caused by the application of N on agricultural land (MPI, 2016). The literature review also revealed that New Zealand is not alone in this problem of fertiliser emissions which was clearly outlined in the Chen et al. (2023) report comparing the comprehensive performance of kiwifruit production in China, Iran and Italy. The study found that across two provinces in China, the entire Italy and Iran, none of the provinces were considered highly sustainable in the long term due to their reliance on non-renewable resources, labour and services and chemical fertilisers. This highlights an important point for kiwifruit grown in a New Zealand setting, as fertiliser is depended on across both conventional and organically grown orchards for economic yields to be achieved (Müller et al., 2016).

3.3 Eco-efficiency

Throughout the literature review, the theme of eco-efficiency (EE) appeared regularly. EE is a concept introduced by Schaltegger and Sturm in 1989 (Ehrenfeld, 2005), emphasising the reduction of environmental impacts while delivering competitively priced goods and services that enhance quality of life (Ehrenfeld,

2005). Holistically, it relates to the idea that economic development should be coupled with reduced environmental impact.

Müller et al. (2014, 2016) has applied this measure to New Zealand grown kiwifruit in two different studies. Firstly, in a study completed in 2014 titled 'Eco-efficiency as a sustainability measure for kiwifruit production in New Zealand', the relationships between yield and carbon footprint (mass-based measure) and area and carbon footprint (area-based measure) were investigated to assess the sustainability of kiwifruit orchards in New Zealand's Bay of Plenty. The study aimed to examine both their environmental and economic performance. The evaluation included different orchard management approaches, such as integrated and certified organic systems, and focused on greenhouse gas emissions (carbon footprint) during the orchard phase. Key findings and conclusions of the study are as follows:

- The choice of the functional unit (land area or 1 kg of produce) did not significantly affect the results.
- While the conventional growing system had slightly higher emissions than the organic system, the EE metric, which considers profitability, favoured organic orchards.
- EE can help differentiate products for consumers and guide orchardists in choosing more sustainable management systems.
- Challenges in achieving sustainability include market volatility and changing consumer preferences.

The second study completed by Müller et al. (2016) aimed to compare the financial and environmental performance of organic and integrated kiwifruit production systems. EE, measured as NZD net profit per kg of GHG was used as a sustainability measure throughout the report as it was recognised as an applicable metric identifying both the value created financially and the environmental impact of an orchard. The study surveyed 40 kiwifruit orchards with both integrated and BioGro certified organic management systems. The key findings from this report were:

- Organic orchards outperformed integrated ones in net profit, despite lower yields, thanks to higher market price.
- Carbon footprints of the two management systems were similar.
- Opportunities for emission reduction exist in fertiliser production, packaging, storage, transport, and optimising nutrient-use efficiency in the orchard.
- EE can help differentiate products and guide orchardists toward more sustainable management.
- Challenges include market volatility, especially in thin markets like organic produce, and changing consumer preferences.

In Zespri's Climate Risks and Opportunities report (Zespri, 2021), they have included a section highlighting the carbon-efficiency of New Zealand grown kiwifruit throughout the shipping process. The section has a table outlining total emissions from shipping in FY20 and FY21, as well as kg carbon dioxide equivalent (CO2-e) per kg of fruit shipped and kg CO2-e per Tray Equivalent (TE). Although this is a similar measurement to EE, it does not have a revenue or profitability element to it. Additionally, one post-harvest facility has reported on EE as Tonnes CO2-e per NZD

$1 million of revenue (Seeka, 2023). For a packhouse facility, this is a useful tool metric to measure as it illustrates the overall carbon efficiency of the operation.

Other than these few instances of EE being used as a metric in the kiwifruit supply chain, there is not widespread adoption of this metric throughout the industry. On this basis, after investigating further into the literature on GHG emissions throughout the kiwifruit supply chain, it was appropriate to dive deeper into the concept of EE, and how this could be applied across a kiwifruit context.

3.3.1 Advantages of Eco-Efficiency

Matzarakis et al. (2004) completed a study of international tourism with the following results.

1. EE is a valuable concept for assessing the environmental and economic performance of tourism and identifying areas for improvement, due to the broad applicability of the concept.
2. The metric can be used in many different municipalities across the globe, as required inputs are generally easy to obtain (revenue, CO2-e).
3. EE analysis can help identify markets with favorable and unfavorable EE, guiding promotional and development strategies.

In another study by Zielińska-Chmielewska et al. (2021), the authors conducted a comprehensive review of domestic and foreign literature pertaining to the concept of EE. This involved classifying and systemising EE measures, particularly in the context of selected food processing enterprises in Poland and outlined the following advantages to using EE as a measure in these enterprises.

- Common decision-making tool for various industries.
- Presents different assessment alternatives in one view.
- Unified calculation system.
- Multiple indicators or a common result can be obtained.
- Comparability of results for companies in the same sector.
- Potential creation of an integrated CO2 performance index.

Although these advantages are specific to industries in these reports, they are applicable across all industries and present themselves as a useful tool in the kiwifruit industry. The main advantages of using EE as a measure in the kiwifruit industry are as follows:

1. EE can be used to compare results within the kiwifruit industry, guiding strategy for areas of improvement.
2. The metric can be used across borders, as the required inputs are consistent.
3. A unified calculation system, easily accessed by stakeholders throughout the supply chain.
4. The measure is simple and easy to understand, allowing for a greater audience to interpret the results.

3.3.2 Disadvantages of Eco-Efficiency

Zielińska-Chmielewska et al. (2021) explored the disadvantages of EE as a measure in the context of the Polish food industry. Although EE provided numerous benefits in assessing this industry, there were also some drawbacks outlined.

1. Narrow field of analysis.
2. Lacks consideration of social aspects within organisations.
3. Does not consider other environmental pressures.
4. Difficulty in standardisation.

The use of EE as a measure of economic and environmental sustainability is outlined in this report as both a useful and limited tool. Although EE may be able to provide a universal, informative metric, the limitations provided above show that it must be considered in conjunction with other measures to paint the full picture.

Ehrenfeld (2005), explains that while EE may be useful for micro-level decisions within organisations, EE may not contribute significantly to addressing global sustainability challenges. He provides a supplementary analysis of some of the drawbacks as shown below.

- Eco-efficiency lacks an explicit connection to the Earth's carrying capacity, making it only partially useful in the context of sustainability.
- The concept combines environmental and economic performance in the context of sustainable development but does not address social aspects of an organisation.
- Quantification is a challenge in EE, involving choosing and enumerating measures for economic value added and environmental impact.
- To be effective, EE should be complemented with other indicators and tools to ensure that increased EE does not result in larger increases in total output, which would be counterproductive in achieving sustainability.

This analysis shows that to use and implement this measure, the user must tread with caution and awareness around what is being illustrated and the limitations of doing so.

Figure 1 illustrates a broad outline of what EE is, and how it is calculated. The reader can start in the top left corner at ‘Environmental Impact’ and follow the diagram anti-clockwise to understand the EE metric as the confluence of economic value and environmental impact. This will be explored further in the report.

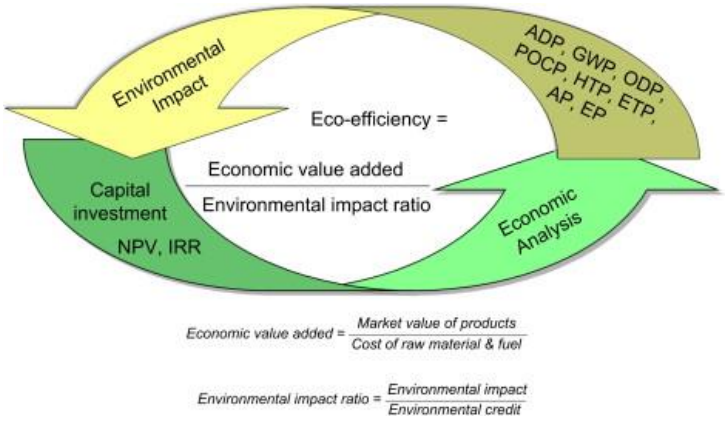


Figure 1 - Eco-Efficiency Explained (Peças et al., 2019)

4. Methodology

4.1 Triangulation

This report utilises triangulation as the primary methodology. Triangulation is the concept of using multiple sources of data or methods to increase the credibility and viability of findings in any qualitative research scenario (Carter et al., 2014). Different types of triangulation include method triangulation (using multiple data collection methods), investigator triangulation (involving multiple researchers), theory triangulation (using different theories), and data source triangulation (collecting data from various sources). Given the qualitative nature of this report, Data Source Triangulation was chosen as the most appropriate method. The three sources of data are outlined in Table 1.

Table 1 - The Sources of Information used for Triangulation Methodology

	Source One	Source Two	Source Three
Grower	Literature review 1. Scientific articles 2. Comparative industries	Semi-structured interviews	Thematic analysis
Post-harvest	Literature Review 1. Existing operator reports 2. Comparative industries	Semi-structured interviews	Thematic analysis
Zespri	Literature Review 1. Trade documentation 2. Published reports	Semi-structured interview	Thematic analysis
Shipping	Literature Review	Semi-structured interview	Thematic analysis

This approach enhanced the research's overall confidence level and produced a more credible set of findings.

4.2 Semi-structured Interviews

The seven key interviews conducted throughout the supply chain are outlined in Table 2.

Table 2 – Summary of Interviews

	Number of interviews	Person one - Employment area	Person two - Employment area
Grower	2	On orchard grower	Management company
Post-harvest	2	Sustainability	Sustainability
Zespri	1	Sustainability	
Shipping	1	Operations/sustainability	
MPI	1	Trade strategy	

Interviews enriched each report section with fresh perspectives, offering deeper insights into economic and environmental implications. This data source proved essential for uncovering non-literature insights, providing up-to-date information, and shaping the report's direction.

4.3 Thematic analysis

Thematic analysis is a qualitative research method used to identify and analyse patterns, themes, and meanings within a dataset (Braun & Clarke, 2006). Throughout both the literature review and key interviews, key themes were identified and expanded on in each section throughout the analysis section (grower, post-harvest, Zespri and shipping). In the interviews specifically, different colour font was used on Microsoft Word documents to identify themes. From here, the themes were arranged in their own documents and cross-checked with the literature to see if any reoccurring themes were present.

Miro software was then used to visually sort key themes into a mind-map, providing an effective way for readers to view this information. Key themes were expanded on in each mind-map to provide a more in-depth analysis. Once confident that the key themes for each section had been identified, an overall summary was reached.

4.4 Project limitations and assumptions

Throughout the process of completing the report, limitations and assumptions became apparent as outlined below.

4.4.1 Limitations:

- Report scope covers from the orchard to overseas port, excluding the retailer and consumer segments (39% of emission footprint).
- Interviews are limited to interviewees' knowledge and experience.
- Interviews with additional stakeholders may have provided a more comprehensive perspective.

4.4.2 Assumptions:

- Assumptions underlie emissions calculations across the entire supply chain (grower, packhouse, Zespri, and shipping). These include the carbon dioxide equivalent (CO2-e) which is used widely as an emission measure.
- Future economic implications of emission reduction practices are assumed by the author of the report in some cases - such as emission reduction activities being continued, current levels of dollar investment and cost-savings.
- The discussion section of the report assumes future natural and economic conditions to provide insight into potential future scenarios.

5. Analysis and Findings – Emission Reduction in the Kiwifruit Supply Chain

5.1 New Zealand Kiwifruit Grower

5.1.1 The Context

The kiwifruit supply chain commences at the orchard, where the fruit is grown, and it serves as a pivotal point where decisions can significantly impact the entire supply chain. While many kiwifruit orchardists actively manage their orchards, some opt to employ management companies to oversee operations.

The emissions embedded in a kiwifruit, as it makes its way to the market, are profoundly shaped by activities at the orchard such as mowing, mulching, spraying, fertiliser and compost use. Given the evolving regulatory landscape, addressing emissions at their source is becoming crucial to deliver kiwifruit products with reduced emissions to the market. Through interviews with industry participants in Zespri's Carbon Neutral Trial (CNT), the report gained deeper insights into the primary sources of emissions at orchards and the most promising opportunities for emission reduction.

5.1.2 The Carbon Neutral Trial

In June 2022, Zespri International initiated a carbon-neutral trial involving kiwifruit growers nationwide. The trial aims to gain insights into on-orchard emissions, addressing market concerns about climate change and consumer demand for environmentally friendly produce (Collen, n.d.). This trial aligns with Zespri's overarching goal of achieving carbon neutrality at the retailer by 2030. Trial participants have been provided with an emission reduction framework, including an interactive Excel spreadsheet for monitoring progress on orchards. Interviews with CNT participants revealed some surprising findings about achievable emission reductions while maintaining yields and profits. It's still premature to draw definitive conclusions about the best areas for emission reduction, but key areas of interest have emerged (Collen, n.d.).

For this grower section, two interviewees were chosen based on their involvement with the CNT as well as time involved in growing kiwifruit. One of the interviewees worked for a post-harvest operator who has an orchard management company and the other was an on-orchard manager of a large kiwifruit company in the Bay of Plenty.

5.1.3 Thematic analysis

Figure 2 outlines the key themes and nuances of each theme, identified for kiwifruit growers through both the literature review and interviews. These themes are expanded on from an emission reduction perspective and the economic implications of each are explored further in Section 6 – Discussion.

Figure 2 - Thematic Analysis Mind Map for New Zealand Kiwifruit Growers

5.1.4 Key themes

Fertiliser use in kiwifruit production

Fertiliser plays a crucial role in orchard management, as it replenishes the nutrients removed when kiwifruit is harvested and not naturally returned to the soil. The choice of fertiliser inputs depends on factors such as geographic location, soil type, and nutrient availability. Common fertilisers used in kiwifruit orchards include Nitrogen, Phosphorous, Potassium, Sulphur, Magnesium, Lime, and Dolomite, all of which come with varying levels of GHG emissions and global warming potential (GWP).

In the interviews, fertiliser emerged as a significant source of emissions, but also one that could be more controlled than others. Growers showed a wide variation in fertiliser inputs, with increasing emphasis on selective application, especially for synthetic fertilisers and nitrogen, often used in combination with compost. To make informed decisions about fertiliser application, growers are intensifying soil and leaf testing to determine which areas require inputs and which are already nutrient-sufficient. This necessitates a cost-benefit analysis, as increased testing costs more upfront but leads to long-term savings on fertiliser inputs. Reduced applications also translate into lower contractor payments and reduced expenses in terms of labour and fuel for growers who apply fertiliser themselves.

Overall, the interviewed growers consistently highlighted the importance of efficient fertiliser application, reducing inputs when unnecessary, and increasing testing for a more targeted approach. This aligns with a study conducted by Müller et al. (2016) on energy efficiency as a sustainability measure in New Zealand kiwifruit production, which pinpointed fertiliser use and N-associated emissions as hotspots for GHG emissions in orchards.

"The use of fertiliser throughout kiwifruit orchards is immense. Whether you're organic or conventional, orchards need inputs to continue producing well and therefor bringing a return to the grower."

Fossil fuels (mowing, mulching, composting, fertiliser, spraying, frost-fans)

Like many agricultural operations nationwide, kiwifruit orchardists heavily rely on machinery powered by fossil fuels to carry out various tasks on their properties. These tasks encompass activities such as mowing, mulching, fertilising, compost application, spraying, and using frost-fans, among others. As part of the CNT, growers have been assigned the task of evaluating their fuel consumption to identify opportunities for enhanced efficiency and cost savings.

One notable example of this is in the context of mowing and mulching. Orchardists take immense pride in the appearance of their orchards and typically engage in regular mowing during the spring and summer months to maintain a neat and well-presented landscape. However, CNT trialists are now experimenting with allowing the grass to grow longer and strategically using different grass varieties to reduce the frequency of tractor usage for mowing.

Furthermore, there is a comprehensive reevaluation of vehicle use across orchards, aiming for greater overall efficiency that will result in reduced emissions. Additionally, some of the larger players in the kiwifruit industry are considering purchasing hybrid and electric vehicles to achieve cost savings and emission reductions. As the cost of petrol and diesel continues to rise nationwide, many growers are increasingly viewing these alternative vehicles as practical options and are starting to incorporate them into their fleets as resources allow.

Spraying

Spraying substances onto orchards, whether they are conventionally or organically grown, is a large part of the annual routine in growing kiwifruit. The CNT identifies this, and like fertiliser or fossil fues, encourages a finer microscope be applied to this activity. Within the spraying activity, some sprays have a higher CO2-e than others meaning that a selective use of sprays could potentially reduce the environmental impact. Growers were certainly hesitant to implement massive changes to their spraying regimes straight away, preferring to tweak applications, due to the considerable impacts caused from omitting sprays at certain times of year.

In aggregate, all growers interviewed talked about the more efficient and selective use of sprays on orchard leading to potential savings in both cost and emissions.

Contractors

Many orchardists utilise the services of contractors to complete the work throughout the kiwifruit season. These activities are wide-ranging, including but not limited to mowing, mulching, spraying, hedge-trimming, compost and fertiliser spreading, vine management, fruit thinning and harvesting. As with many industries, these activities have all traditionally emitted GHG into the atmosphere, predominantly through the burning of fossil fuels in tractors and machinery but also including vehicles to reach site before work has started. Throughout the key interviews, contractors were identified as one of the primary areas for on-orchard emissions and recognised that this could be reduced.

"Fossil fuels are used in so many parts of the kiwifruit growing process – whether the orchard is managed by the grower themselves or by a management company, everyone depends on petrol and diesel to get the job done."

Transport

Transport plays a key role in kiwifruit orchards around New Zealand. Like many commercial activities, kiwifruit growing requires materials to be delivered to site, including compost, fertiliser and equipment for example. Supplementary to this, transport services are required to take fruit from the orchard to the packhouse after harvesting. Generally, across kiwifruit orchards in New Zealand, these transport services are operated using diesel trucks as viable alternatives are not yet available. The use of trucks adds a significant amount of to an orchardist's total GHG emissions due the frequency of use and GWP of the fossil fuels. The main area where some

orchardists are trying to reduce emissions from this source is around efficiency, having less fertiliser and compost delivered to site and ensuring that trucks are completely laden during harvest for example.

Embedded carbon and influence

Embedded CO2-e is generally found in all infrastructure and materials on a kiwifruit orchard. When considering the overall carbon footprint of any operation, organisations are increasingly considering other inputs-related emissions as outlined in the report completed by Hertwich and Wood (2018). Regarding orchard infrastructure, some examples are wooden posts, hail netting, steel framing (Agbeam), steel wire, building materials in on-site structures, as well as any products brought onto site for the growing process. Although these embedded emissions are difficult to control or reduce once installed, growers in the CNT are noting their emission level and aiming to potentially reduce this when building anything new. One way that growers can influence scope 3 emissions is through influencing suppliers. Some growers are large enough on their own to demand lower carbon products, and others can band together to have a large enough impact on these decisions.

Ecosystem restoration

Many kiwifruit orchards are located near gullies, wetlands or land that was previously covered in native forest. As part of their long-term environmental plans and carbon sequestration, some orchards are taking the opportunity to plant native trees and restore wetlands or gullies in areas of land that are not required for either kiwifruit or buildings etc. Not only does this have a great aesthetic appeal, but it also potentially qualifies landowners for additional income, if not now then into the future. Native plantings are already eligible for carbon credits under the emissions trading scheme and there is consultation currently being completed for a biodiversity credit system. Although these plantings may not financially pay off immediately, they are a long-term investment that also contribute to the health and well-being of the area.

Potential for collaboration

One consistent theme throughout the key interviews conducted was collaboration in the industry. As it stands, the kiwifruit industry in New Zealand is remarkably collaborative, assisted by having a single point of export in Zespri. Growers noted that this is a large advantage to the industry and should be utilised as much as possible when it comes to reducing CO2-e emissions and moving toward a carbon positive future. One significant example of this is collaborating to create influence on suppliers of materials as mentioned above. Additionally, collaboration across the industry on carbon reduction would also enhance the willingness and motivation for growers to be involved.

"The industry already has great collaboration in so many ways, we should harness that more in the emission reduction space so we can all work together on achieving these goals. Communication is key."

Summary

The key themes explored above outline the existing emission reduction activities taking place on orchards participating in the CNT. As the program is only a year old, both the emission reduction and economic implications of these are not yet certain. What is clear however, is that some of these practices, such as reducing fuel use through mowing and mulching, will have an impact on emissions due to existing knowledge on the environmental impact of burning fossil fuels. The economic impact of these activities is further explored in Section 6 – Discussion.

5.2 Post-harvest Operators (Packhouse)

5.2.1 Introduction

The post-harvest segment of the kiwifruit supply chain is made up of approximately 53 facilities that operate to procure, pack, store, quality check and dispatch trays of kiwifruit (NZKGI, n.d.) These companies play a vital role in the supply chain, ensuring a quality product is supplied to Zespri to export overseas. Within this segment, facilities range in size and efficiency, with some of the larger facilities packing up to 25% of market share, while smaller facilities are less than 1%. Being such a critical part of the chain, packhouses have a significant contribution to total emissions of kiwifruit in the market – quantified at 11% for the 2017 crop (Zespri, 2020). To gain a deeper understanding of this sector, and to identify areas of potential emission reduction, two interviews were conducted with employees at packhouses in the Bay of Plenty. Their knowledge of the emission reduction space was vast; however, the economic implications of these activities were less known. Their responses, along with associated materials are explained below.

5.2.2 Thematic analysis

Figure 3 outlines the key themes found for emission reduction at the packhouse level throughout the kiwifruit supply chain. The environmental impact of these themes is further explored in this section of the report, and the economic impact is investigated in Section 6 – Discussion.

Photograph: istockphoto.com

Figure 3 - Thematic Analysis Mind Map for Post-harvest Operators

5.2.3 Key Themes

One of the most effective ways to gather information about the post-harvest segment of the supply chain was to conduct interviews with key sustainability staff. These people are working directly for post-harvest entities, with the goal of creating more environmentally friendly workplaces from a range of angles. One thing that was highlighted throughout this process was the varying degrees of emission reduction efforts across the different entities as well as the resource that some were willing to commit. The key areas of emission reduction outlined by interviewees are identified below.

Solar installation in packhouses

The primary function of a post-harvest facility is to store kiwifruit for extended periods after packing. Typically, once the fruit arrives from the orchard, it is swiftly packed into boxes and then transferred to a cool store, where it can remain for as long as 6-8 months. Consequently, packhouses essentially operate large refrigeration facilities for a significant portion of the year. These cool stores are substantial consumers of electricity, vital for maintaining the quality of kiwifruit intended for overseas export. Electricity costs generally rank among the top five expenses on these facilities' income statements, as indicated in the Apata Annual Report (2022).

Historically, the electricity required for these operations has been drawn from the national grid, indirectly contributing to carbon emissions. To reduce their reliance on the national grid, some facilities have begun installing solar panels on-site, providing 100% renewable and clean energy. This investment not only liberates these facilities from grid electricity prices but also offers long-term cost savings through energy generation, storage, and, in some cases, the ability to sell excess power back to the national grid. Furthermore, this shift toward on-site electricity generation enhances overall resilience, reducing the risk of disruptions in the national grid that could leave packhouses unable to refrigerate their kiwifruit.

Energy efficiency in cool store

In conjunction with efforts to become more energy self-reliant, some post-harvest operators have become more strategic in their use of energy throughout the kiwifruit cooling period. By utilising the natural outside temperature overnight during winter, in some cases cool stores can be turned off for 3-4 hours overnight to conserve the use of energy. When the temperature outside begins to heat up again in the early hours of the morning, the cool store is once again switched on and the refrigerators utilised. Given the value of the fruit that sits in these stores, often more than $1m, this strategy can be reasonably high-risk and has therefore not yet been rolled out at scale across the industry.

Refrigerant leak reduction

Another vitally important element of the cools stores is the use of refrigerant gases in these systems. Throughout the industry, many of the cool stores were built in the 1970s – 1990s at a time when the technology available for refrigerants was harmful to the environment from an emissions perspective. Refrigerant liquid is purchased from merchants in New Zealand, which is then utilised in cool store systems,

changing the state of the liquid to gas to keep the stores cold. Occasionally, these systems fail and experience a leak, emitting hydrofluorocarbons into the atmosphere which contributes to a greenhouse gas effect. These gases have high global warming potential (GWP), in some cases as much as 3920x the GWP of carbon dioxide in the atmosphere (Trevelyan's Pack n Cool, 2022). Over the last 5-10 years, this effect has been recognised by some post-harvest facilities and an effort has been made to reduce the leaks in a selection of ways. Firstly, investment has been made into the pipework that the gases travel through, to remove any vulnerable 45-degree bends which are more likely to stress and fracture over time. Additionally, packhouses have invested in leak detection technology, specifically handheld devices, that staff can use to identify suspected leaks in cool stores and periodically check to ensure the system remains tight. This has led to a reduction in leaks for those that have invested. Furthermore, new technology has also been made available for cool store operators to utilise natural gas systems that possess a drastically lower carbon footprint when emitted into the atmosphere. Examples include the use of ammonia and carbon dioxide systems. Despite the highly expensive cost to either retrofit existing stores or build new ones, some post-harvest facilities have started investing in these technologies.

"Refrigerant leaks have been an expensive issue for packhouses for many years, but the technology has only recently become available to truly fix this. The problem is the expense of fixing the stores, it's cost prohibitive."

Waste management

Managing waste on a kiwifruit post-harvest site is an important aspect of sustainability and has a considerable impact on emissions. In the operations of a packhouse, there are many sources of waste including food scraps, packaging, general office waste, fruit dust among others. Traditionally, packhouses have delt with these waste streams like most industrial operators, either collecting it into skip bins or dropping it to the waste processing facility themselves. Over the last five or so years, some operators in the industry have started to process their waste themselves on site, and creating the likes of worm farms to turn food waste into compost. These sites have seen a positive impact from this investment by reducing the need to travel to the waste facility and avoiding waste facility gate fees as well. Consequently, the emissions profile has reduced (less diesel used) and cost savings have contributed to the bottom line of these operators.

LED light upgrades

Some post-harvest facilities are rolling out LED light upgrades across their facilities. The primary reason behind this is energy efficiency, as the LED lights use up to 70% less power than standard light bulbs (Seeka, 2023). Given these businesses have large amounts of infrastructure requiring lighting, (offices, cool stores, distribution centres), there is a significant opportunity for energy savings across a range of facilities. This LED installation initiative ties in with the larger energy efficiency strategy of some post-harvest facilities and is a reasonably cost-effective measure. As with

the installation of solar, the installation of LED lightbulbs also plays a vital role in resilience for the future, because power consumption is reduced.

Transition to hybrids and electric vehicles

In alignment with the broader strategies set out by the New Zealand Government, certain packhouse facilities are making the transition to hybrid or electric vehicles within their fleets. The kiwifruit post-harvest industry relies considerably on vehicles, with larger facilities typically maintaining fleets comprising at least 50 vehicles. Many of these operators encompass orchard management companies within their operations, with each orchard manager typically being provided with a 4WD vehicle, along with sales representatives and the leadership team.

By incorporating hybrids, plug-in hybrids, and electric vehicles into their fleets, these facilities have managed to curtail their annual emissions. Further, these facilities are taking steps to install electric vehicle chargers on-site, covering the charging costs, which alleviates the burden on staff members. A significant advantage of this approach is the anticipated long-term cost savings, particularly as petrol and diesel prices in New Zealand are projected to continue rising (RNZ News, 2022).

It's worth noting that while transitioning to an EV or hybrid fleet is feasible for some departments, it currently presents challenges for a widespread rollout due to the necessity of larger 4WD vehicles for staff who navigate orchards or transport equipment.

Scope-3 emission reduction

The ability to further reduce the GHG emissions of post-harvest facilities is enhanced by the influence that some of the large facilities have over their suppliers. The most prominent example of this is in packaging, due to the large volumes purchased in any given season. More proactive organisations are using this influence to demand lower embedded carbon in their packaging contracts, thereby reducing their scope-3 emissions profile and overall footprint. Some facilities are also demanding that waste be collected or returned to the supplier. This requirement is a symptom of a larger overall trend, as suppliers look to reduce their own emissions profiles to mitigate this risk and be ready for further regulation. There are several suppliers that these facilities may have influence over, including but not limited to packaging, administrative materials, repairs, and maintenance materials among others.

"If companies use their collective influence toward suppliers, the industry could make real progress towards reducing scope 3 emissions and the overall carbon footprint of the industry."

Transport

Transport makes up a considerable portion of te post-harvest operators emissions with the required use of transport services to and from the packhouse. Some of the transport activities include delivering fruit, packaging, materials, and equipment to

the packhouse, and collecting full pallets and containers of fruit to be transported to the port. Transport is included in the supply chain (or scope 3) emissions for a packhouse, so it can be difficult to discern whose responsibility it is to work towards emission reduction in this area. Some facilities are aiming to reduce transport emissions by either using influence on their transport suppliers (pressure to reduce emissions) or being more efficient in the use of transport to and from their sites.

5.2.4 The Importance of Governance

Governance plays a pivotal role in curbing emissions within the post-harvest phase of the kiwifruit supply chain. A study completed by Khan et al. (2022) underscores the significant contribution of effective governance to both short-term and long-term greenhouse gas (GHG) reduction. The study emphasises how governance is instrumental in advancing environmental sustainability across stakeholders, facilitating widespread adoption, and maintaining a sustained decrease in GHG emissions.

Through discussions with post-harvest facilities, the critical importance of governance was mentioned, prompting some facilities to establish governance structures to ensure the longevity of their efforts. In these instances, it was believed that these governance mechanisms fostered a lasting corporate culture, encouraging employees and stakeholders to embrace environmentally friendly practices. Moreover, governance structures play a pivotal role in ensuring that organisational frameworks and structures are well-suited to their purpose, further promoting a culture of emission reduction.

5.2.5 International Example: Berry Gardens Growers Ltd (Berry Garden's History, n.d.)

Berry Gardens Growers Ltd is a prominent UK grower-owned co-operative established in 1972. They specialise in growing berries, cherries, and plums, supplying major British supermarkets from March/April to November. The cooperative consists of 42 growers across the UK, spanning from Kent in the south to Scotland in the north, each known for their exceptional land and growing expertise. These growers, while individual entities, share a commitment to innovation and sustainable land management.

Berry Gardens has made significant strides in sustainability with the installation of a state-of-the-art solar system at its packhouse, which has saved over 250 tonnes of carbon dioxide emissions, equivalent to planting over 11,500 trees (Berry Garden's History, n.d.). The packhouse features 3,614 solar panels, covering 6,143 square meters on the roof, making it the largest solar energy system of its kind. The facility, valued at £20 million, is designed with sustainability in mind, aiming to become fully sustainable and carbon neutral in the future.

Other eco-friendly features include zero waste to landfill, electric vehicle charging points, energy-efficient refrigeration, a living wall, extensive tree planting, a biodiversity site to enhance wildlife habitat, recycling systems, and efficient waste management (Berry Garden's History, n.d.).

In the context of a kiwifruit packhouse, this highlights the potential benefits of adopting sustainable and eco-friendly practices. These practices include the installation of renewable energy sources like solar panels, efficient waste management, and fostering biodiversity. Such initiatives can reduce carbon emissions, enhance environmental sustainability, and contribute to a more efficient and responsible supply chain. Additionally, the focus on quality and efficient transport can serve as an example for preserving the freshness and taste of kiwifruit during the post-harvest phase (Searle, 2021).

Summary

There are proven ways to reduce emissions in the post-harvest segment as explored above. With international examples such as Berry Gardens Growers Ltd, we can see that implementing these practices will contribute to a reduction in emissions entering the atmosphere from activities throughout this sector. In Section 6 – Discussion, these key themes are further investigated from an economic perspective, to analyse the economic viability of implementing these measures as well as the international market opportunity.

5.3 Zespri

5.3.1 Introduction

The kiwifruit industry in New Zealand operates under regulation, primarily governed by the Kiwifruit Industry Restructuring Act 1999 and the Kiwifruit Export Regulations 1999. These regulations establish Zespri as the main exporter of New Zealand-grown kiwifruit to all countries except Australia, a system known as the Single Point of Entry (SPE) or 'single desk' (NZKGI, n.d.). While the Regulations allow some provision for other marketers to export kiwifruit through collaborative marketing arrangements with Zespri, this represents a small portion of the country's kiwifruit exports. In 2015, a referendum known as the Kiwifruit Industry Strategy Project referendum saw over 97 percent of growers supporting the existing industry structure, leading to the Kiwifruit Export Amendment Regulations 2017 (NZKGI, n.d.).

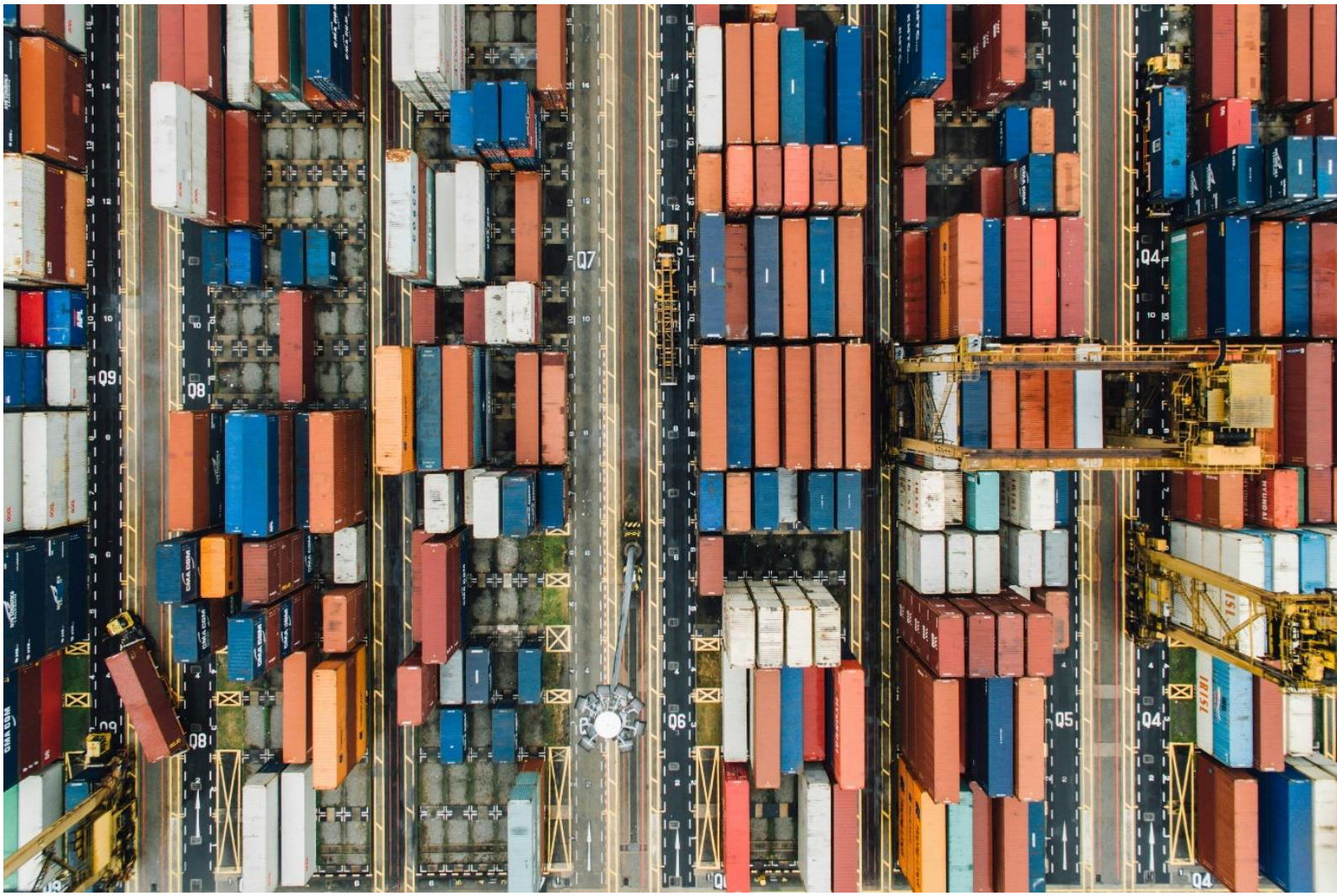
This system allows Zespri considerable influence over the industry, as they are not commercially pressured by export competitors throughout the country. The company has seen consistent success over the 20 or so years in operation, and continues to be one of the icons of New Zealand exports (Zespri, 2019). With this success certainly comes responsibility, however. Being responsible for the livelihoods of many families and businesses when they have no other option but to supply Zespri, brings an obligation to perform at a high level.

Regarding GHG emission reduction, Zespri has taken a proactive approach in tackling these issues over the last 5-10 years. They have established a significant sustainability team and are pursuing various strategic initiatives to advance the company towards ambitious goals. These include the Zespri corporate to be carbon neutral by 2025 and supporting the global supply chain to become carbon positive to retailers by 2030.

This section is broken into two parts – the domestic environment (Zespri corporate and domestic influence), and the macroeconomic environment (trade agreements, market demand etc.). As Zespri has considerable sustainability resources available throughout the company, a member of this team was chosen to interview. This allowed the report to gain deeper insight into emission reduction activities, and to a lesser extent the economic implications of these activities.

5.3.2 Thematic Analysis

Figure 4 outlines the key themes identified throughout the literature review and key interviews for Zespri International. These are outlined on two sides of the diagram, one being the international environment and the other domestic.



Photograph: istockphoto.com

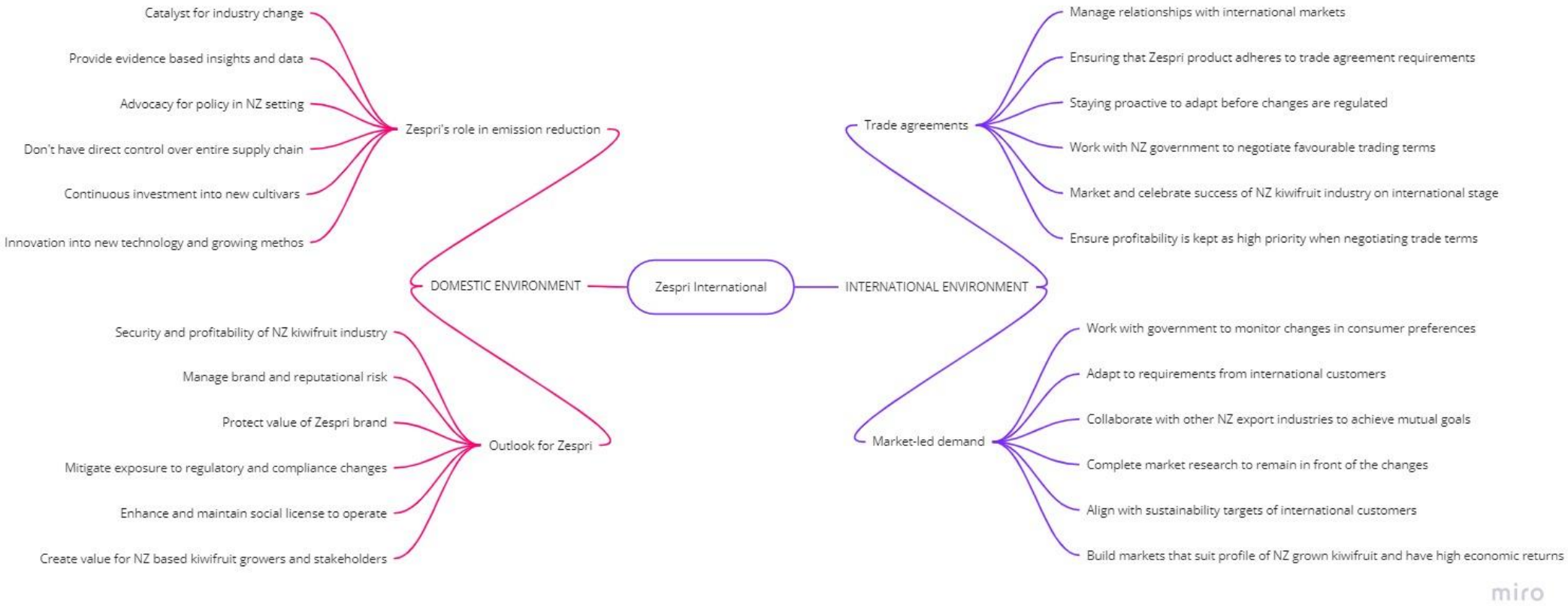


Figure 4 - Thematic Analysis Mind Map for Zespri

5.3.3 The Domestic Environment

Through the sources of both key interviews and literature review, an analysis was completed on the role of Zespri in the domestic setting within New Zealand, for reducing GHG emissions throughout the supply chain.

Zespri's Role:

Zespri perceives its role as a catalyst for change within the kiwifruit industry (Zespri, 2022). They provide evidence-based insights, data, and advocacy to inform policy development, enabling industry stakeholders to make informed decisions. As a grower-owned business, Zespri manages the marketing and export of kiwifruit while championing innovation and maintaining quality standards. They lack direct control over the supply chain, including orchards, packhouses, and cool stores, relying on supply chain partners to adapt to evolving challenges, including those related to climate risks and opportunities. Nevertheless, Zespri invests in the development of new cultivars and innovative approaches to advance the kiwifruit industry (Zespri, 2020).

In the fiscal year 2021, Zespri made significant strides in its performance with a 90% reduction in corporate emissions, mainly attributed to the reduced global travel that resulted from the COVID-19 pandemic. This positive trend demonstrates the potential for reducing Zespri's carbon footprint, especially through remote and virtual work practices, which present opportunities to further lower emissions and align with the ambitious goal of achieving carbon neutrality by 2025. It is important to note that emissions in the supply chain are not solely within Zespri's control, with industry emissions, particularly from shipping, representing a substantial share of the total emissions. Zespri is fully aware of the imperative need for effective emissions reduction strategies and is actively collaborating with shipping partners to develop pathways for emissions reduction to address this pivotal aspect of its sustainability efforts.

"Zespri role is a marketer, innovator, and seller. Outside of the corporate's own direct emissions, there is only so much impact Zespri can have on supply chain emissions."

Outlook

Zespri sees a transformative vision for its business and wider industry, with the aim of achieving carbon-positive growth (Zespri, 2021). Central to this mission is the encouragement of nature-based climate solutions, offering incentives for their adoption. While the focus remains on reducing emissions, Zespri's approach extends beyond mitigation, and embraces bold and innovative strategies that combat climate challenges and harness the opportunities they present.

The following areas were identified as the main opportunities for Zespri moving into the future.

1. Security and Profitability: Zespri aims to ensure the security of its supply chain while maintaining profitability.

2. Brand and Reputational Risk: Focused on reducing brand and reputational risks associated with their operations.

3. Protecting Value: Zespri is committed to safeguarding the value of its products and brand.

4. Cost Reduction and Regulatory Compliance: Seek to reduce costs and mitigate exposure to regulatory changes.

5. Public Perception and Social License: Zespri recognises the importance of public perception and maintaining a social license to operate.

6. Creating Value: Zespri is increasingly focusing on creating value through various means, including:

a. Enhancing intangibles such as talent retention and attraction

b. Influencing consumer purchasing behavior and potentially commanding premium prices

c. Exploring new revenue streams

d. Improving land and fruit quality

e. Ongoing exploration of ways to create value.

5.3.4 Existing Industry Carbon Footprint

The following graph outlines the contribution from each part of the supply chain to the kiwifruit industry's overall GHG emissions (Zespri, 2020).

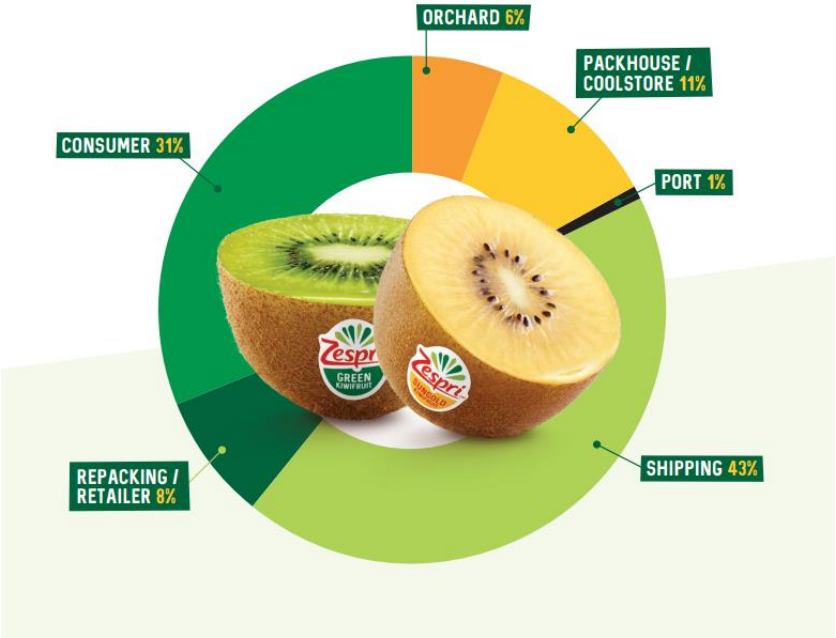


Figure 5 - Emission Contribution for each Segment of the Kiwifruit Supply Chain (Zespri, 2020)

5.3.5 The Macroeconomic Environment

Given that Zespri exports nearly 100% of kiwifruit grown in New Zealand (NZKGI, n.d.) the industry is subject to the international trading environment including trade policy, government regulations and geopolitical relations. This section aims to highlight some of the key environmental challenges and frameworks in the international environment that Zespri must consider with its key trading partners. At the bottom of each trade agreement summary, tables are provided to provide context about the size of the market for Zespri.

NZ "Trade for All" agenda

The "Trade for All" initiative in New Zealand aims to reevaluate the country's trade policy to ensure it benefits all citizens (Benson & Duncan, 2022b). Trade is vital for the economy, and the government seeks policies that promote broad prosperity. The initiative was developed through extensive consultation in 2018 and led to the creation of a "Trade for All" Advisory Board. This Board provided independent recommendations for trade policy, addressing global and regional concerns such as environmental issues and labour standards.

The initiative considers aspects of trade policy, including involvement in international organisations, negotiation of trade agreements, and the interaction between trade and domestic economic policies. It emphasises sustainable and inclusive economic development, while considering environmental impact and benefiting all citizens, including women, Māori, and small to medium-sized enterprises.

Key principles approved for Trade for All include open consultation with the public, focusing on creating sustainable economic opportunities for all citizens, supporting international rules-based systems, enhancing economic integration in the Asia-Pacific region, addressing global issues like climate change and labour rights, and preserving the government's right to regulate for the public interest.

For kiwifruit growers and processors in New Zealand, this paints a reasonably clear picture of what direction our government is heading with trade into the future. Along with women, Māori, and small to medium-sized enterprises, MFAT is giving priority to decarbonising the economy and ensuring environmental impact is measured and reduced. This will have an impact across the entire supply chain for New Zealand grown kiwifruit, including growers, post-harvest operators and Zespri (Ministry of Foreign Affairs and Trade, 2019).

New Zealand-European Union Free Trade Agreement

The New Zealand-European Union Free Trade Agreement (FTA) was signed on 9 July 2023, marking a significant milestone for both trading blocs as well as other countries around the world (Ministry for the Environment, 2021). As well as commitments relating to labour and human rights, the document commits both partners to adhere to their Paris Climate Accord obligations. Under the Paris Climate Accord, New Zealand's Nationally Determined Contribution (NDC) is:

- To reduce net greenhouse gas emissions to 50 per cent below gross 2005 levels by 2030.

- This corresponds to 41 per cent when managed using a multi-year emissions budget starting from New Zealand's 2020 emissions target. Based on New Zealand's most recent greenhouse gas inventory, this budget provisionally equates to 571 Mt CO2-e over 2021 – 2030.
- The NDC is contextualised by New Zealand's aims under the Paris Agreement to hold the increase in the global average temperature to well below 2°C and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels (Ministry for the Environment, 2021).

In the context of New Zealand exported kiwifruit, these commitments are significant due to the sheer volume of kiwifruit exported into the EU. For 2023, total kiwifruit exports to the EU totaled $1.226 billion, with this forecast to rise steadily over the next 10 years (Zespri, 2022). Additional to this, Zespri-owned subsidiary Zespri Global Supply, which grows kiwifruit outside of New Zealand, supplies ~26 million trays grown in the EU meaning that not only is the FTA governing the exports of New Zealand grown kiwifruit, but the exports of European grown kiwifruit.

A summary of the key statistics for this market is provided in Table 3.

Table 3 – Europe Zespri Market Value - Derived from Zespri Annual Report 2022/2023 (Zespri, 2023)

Market	Export Value 2023	Zespri Total Exports 2023	% of Zespri Sales
European Union	$1,226.02M	$3,920M	31%

Carbon Border Adjustment Mechanism

In addition to the Paris Climate Accord obligations under the FTA, the EU also began utilising another tool in 2023 to ensure the low emissions of imports into the union. The EU is enhancing its own climate goals, but there's a concern about "carbon leakage." This happens when EU-based companies relocate carbon-intensive manufacturing to countries with weaker climate regulations or when more carbon-intensive imports replace EU products.

To address this, the EU has developed the Carbon Border Adjustment Mechanism (CBAM). This tool establishes a fair cost for the carbon emissions produced during the manufacturing of goods entering the EU. It also promotes cleaner production practices in non-EU countries. The CBAM's implementation aligns with reducing free allowances in the EU Emissions Trading System (ETS) to support EU industry's move toward decarbonisation.

The CBAM guarantees that a fee is paid for the carbon emissions embedded in certain imported goods, ensuring their carbon cost is on par with domestically produced items. This prevents EU climate goals from being undermined. The CBAM is designed to adhere to World Trade Organisation (WTO) regulations.

CBAMs could have a considerable effect on New Zealand kiwifruit exported to Europe in the coming decade and beyond. With EU producers required to meet

highly stringent standards of decarbonisation, the EU Commission will be ensuring that any agricultural import into the union meets these standards. For New Zealand kiwifruit producers this means one of two things; either kiwifruit is grown and processed adherent to the stringent environmental standards of the EU, or the price of buying CBAMs is accepted and integrated in the economic model (European Commission, n.d.).

New Zealand-China Free Trade Agreement

In 2008, New Zealand and China established a free trade agreement (FTA), marking a significant milestone in their relationship. This agreement has fostered substantial trade growth and closer collaboration in various areas. New Zealand's exports to China have multiplied fourfold since the agreement's inception, solidifying China as its primary trading partner, with a trade volume exceeding NZ$37 billion in 2021. Additionally, China has become a vital contributor to New Zealand's tourism, education, and investment sectors.

In April 2022, an upgraded version of the New Zealand-China FTA came into effect, aligning the original agreement with current trade policies and practices. This update encompasses areas such as e-commerce, government procurement, environmental standards, competition regulations, and it reduces barriers for exporters.

The agreement underpins New Zealand's sovereignty to regulate in the public interest and includes protections for the Treaty of Waitangi. The Treaty's prominence is preserved, and New Zealand's interpretation remains unchallenged under the agreement's dispute resolution mechanisms.

For the New Zealand kiwifruit industry, this FTA doesn't currently contain specific provisions that mandate significant GHG reduction measures. Presently, New Zealand kiwifruit can be exported to China without being subject to a "carbon" test or the requirement to disclose how it was grown or processed. Since Greater China (including Hong Kong and Taiwan) represents Zespri's largest trading partner, any policy changes could have significant implications for kiwifruit supply into this market. Nevertheless, the 2022 changes to this FTA aimed to align it with current trade policies, including New Zealand's "Trade for All" agenda. While it doesn't have a direct impact on kiwifruit exports now, this alignment may pave the way for the regulation and enforcement of environmental standards in the future (Ministry of Foreign Affairs and Trade, n.d.).

Table 4 – Greater China Zespri Market Value - Derived from Zespri Annual Report 2022/2023 (Zespri, 2023)

Market	Zespri export value 2023	Zespri total exports	% of Zespri sales
Greater China (China, Hong Kong, Taiwan)	$1,036.81M	$3,920M	26%

ASIA PACIFIC – Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)

Agreement Summary

The Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) is an FTA involving 11 countries in the Asia-Pacific region, which has been under negotiation since 2015 and was ratified by New Zealand in 2018. The agreement is designed to go beyond just reducing business costs. It includes commitments to uphold high labor and environmental standards, New Zealand's regulatory rights, and the Treaty of Waitangi. The CPTPP replaces certain elements from the original Trans-Pacific Partnership (TPP) after the United States withdrew. The CPTPP is crucial for New Zealand, as it helps maximize trade value, support the economy, create jobs, and improve the standard of living. The agreement involves economies representing 13.5% of global GDP, with New Zealand benefiting from expanded access to markets in countries like Japan, Canada, Mexico, and Peru, offering significant opportunities for exporters and contributing to a better quality of life for New Zealanders (Ministry of Foreign Affairs and Trade, 2018).

Environment chapter summary

The Environment chapter of the CPTPP aims to promote mutually supportive trade and environmental policies. It includes commitments related to several areas, such as multilateral environmental agreements, biodiversity conservation, carbon emissions reduction, sustainable fisheries management, combating illegal trade in wildlife, and liberalising trade in environmental goods and services. The agreement makes a general commitment toward working together to "address climate change", and "pursue high levels on environmental protection", however doesn't outline specific targets for emissions reduction or other environmental measures. The chapter encourages the use of voluntary mechanisms for environmental protection. The obligations in this chapter are consistent with New Zealand's existing domestic laws and international commitments (Ministry of Foreign Affairs and Trade, n.d.).

Table 5 outlines both the market sizes of each member of the CPTPP as well as the signature, conclusion, and effective date of each country's membership to the CPTPP. There are many other member states, however the members in Table 5 are considerable markets for Zespri.

Table 5 – CPTPP Zespri Market Value - Derived from Zespri Annual Report 2022/2023 (Zespri, 2023)

Country	Zespri export value 2023	% of Zespri sales	Signature date	Conclusion date	Effective
Japan	$757.39M	19%	8-Mar-18	6-Jul-18	30-Dec-18
Australia	$63.43M	2%	8-Mar-18	31-Oct-18	30-Dec-18
Vietnam	$28.58M	1%	8-Mar-18	15-Nov-18	14-Jan-19
Singapore	$34.21M	1%	8-Mar-18	19-Jul-18	30-Dec-18
Total	**$883.61M**	**23%**			

NORTH AMERICA – USA

New Zealand and the USA do not have an FTA, however do have an official document in place to establish common trade and investment principles across the two countries. The Trade and Investment Framework Agreement (TIFA) was signed in October 1992 between the two governments, which established a TIFA council as the primary mechanism for trade discussions between the two countries (United States Trade Representative, 1992). Prime Minister Jacinda Adern and President Joseph Biden met in May 2022 to discuss many things including trade and economic prosperity for the Indo-Pacific region. Although the two leaders discussed climate change as one of the largest issues facing the entire region in the 21st Century, there were no commitments or pledges made regarding emission reduction targets for market access or trade across the two nations (The White House, 2022). On this basis, we can conclude that New Zealand-USA trade can continue to grow into the future, without necessary emission reductions to ensure market access.

Table 6 – USA Zespri Market Value - Derived from Zespri Annual Report 2022/2023 (Zespri, 2023)

Market	Zespri export value 2023	Zespri total exports	% of Zespri sales
USA	$269.80M	$3,920M	7%

Korea-New Zealand Free Trade Agreement

New Zealand and South Korea have a longstanding history of collaboration, initially dating back to New Zealand's involvement in the Korean War. They share common values like democracy, open market economies, and respect for the rule of law, fostering strong political, economic, and people-to-people connections. The Korea-New Zealand Free Trade Agreement (KNZFTA), signed in 2015 and effective since late 2015, has significantly enhanced their bilateral relationship.

South Korea is a vital trading partner for New Zealand, with two-way trade valued at $5.38 billion in 2021. Currently, it ranks as New Zealand's sixth-largest trading partner. South Korea is the fifth-largest destination for New Zealand's exports and the seventh-largest source of imports.

Aside from the benefits to this two-way FTA, there is no reference in this document towards environmental standards or emission reduction targets for trade between the two nations. In December 2021 both countries endorsed a work plan to review the agreement to look at ways in which bilateral trade and investment can be further expanded and promoted. Although this could loosely be interpreted as modernising the agreement to include emission reduction targets and obligations, there is no specific reference to this (Ministry of Foreign Affairs and Trade, n.d.).

Table 7 – South Korea Zespri Market Value - Derived from Zespri Annual Report 2022/2023 (Zespri, 2023)

Market	Zespri export value 2023	Zespri total exports	% of Zespri sales
South Korea	$276.04M	$3,920M	7%

5.3.6 Key Interview

The interview shed light on the Ministry of Primary Industries' (MPI) role in international trade, highlighting its collaboration with the Ministry of Foreign Affairs and Trade (MFAT) in negotiating FTAs. While MPI focuses on various agendas, MFAT often handles discussions related to environmental aspects during these negotiations.

Kiwifruit in New Zealand benefits from a strong global reputation for environmental standards, with the name "kiwifruit" aligning with the country's clean, green image. This positive perception remains valuable for marketing NZ-grown kiwifruit, and the fruit industry enjoys an environmental advantage compared to meat and dairy production.

The interview also touched on protectionist measures in international trade. While New Zealand faces challenges in negotiating FTAs, such as with the dairy industry in India, kiwifruit is not as commonly protected in these agreements due to its limited global growing areas.

Lastly, there is a growing market-driven demand for sustainably produced goods and low-emission supply chains. International customers, including Tesco in the UK, are exerting pressure on producers to reduce emissions and improve practices. Tesco, for instance, has requested emission data from New Zealand products starting in 2030, as outlined in this report and Appendix 1.

5.3.7 Market-led demand

Supplementary to the governmental trade landscape changing for New Zealand producers, there is also a large shift in consumer demand toward more fossil fuel free products. Throughout the world's developed markets, consumer awareness towards climate change and emission reduction is on the rise and consequently producers are having to change their production to comply.

A recent report (Yara - Knowledge Grows, 2023) highlights the significant role of food production in global greenhouse gas emissions, with over a quarter of emissions attributed to it. The report reveals that 58% of Europeans prioritise the climate impact when purchasing food and drinks, and 51% are willing to pay extra for food produced without fossil fuels. However, many find it challenging to identify climate-friendly food, with 76% wanting carbon footprints displayed on food labels.

Key survey findings include:

- 58% of Europeans prioritise climate impact when buying food and beverages.

- 69% would opt for a climate-friendlier food item over a cheaper one, with 26% choosing fossil-free and 43% preferring low-carbon options.
- 51% are willing to pay more for food produced without fossil fuel sources.
- 31% already make sustainable purchasing choices.
- 76% want to see carbon footprints displayed on food labels.
- 74% believe food companies should work to reduce emissions in their production processes.

Tesco, a British multinational grocery chain, has set sustainability requirements for all its fresh meat, dairy, and produce suppliers, including those from New Zealand. This move is expected to encourage New Zealand farmers to align with the government's climate targets, particularly in reducing agricultural emissions.

Tesco aims to achieve a net-zero supply chain by 2050, with a significant milestone of having 100% of its sourced fresh products, such as meat and dairy, environmentally accredited by 2030. The supermarket acknowledges that a substantial portion of its emissions comes from farming, including its purchases from New Zealand, where it buys a significant amount of meat products.

Tesco's announcement serves as a strong signal to New Zealand farmers to align with the sustainability standards of their major markets and meet the government's climate targets. Although Tesco's is not a huge customer of Zespri kiwifruit, this market is set to grow and therefor NZ based growers will be subject to these requirements. Although this announcement does not have a huge initial impact for kiwifruit, the sentiment is clear and is likely to proliferate among major markets.

Summary

In conclusion, Zespri has a large scope to consider when tackling the challenge of emission reduction. This includes both the domestic environment and in an international setting. The global trade landscape and market demands are leaning toward sustainability and lower emissions, meaning that Zespri must continue to adapt to meet market requirements. While the immediate impact may vary, these trends signal the need for environmental considerations and potential regulations in the kiwifruit industry's future.

5.4 Shipping

5.4.1 Introduction

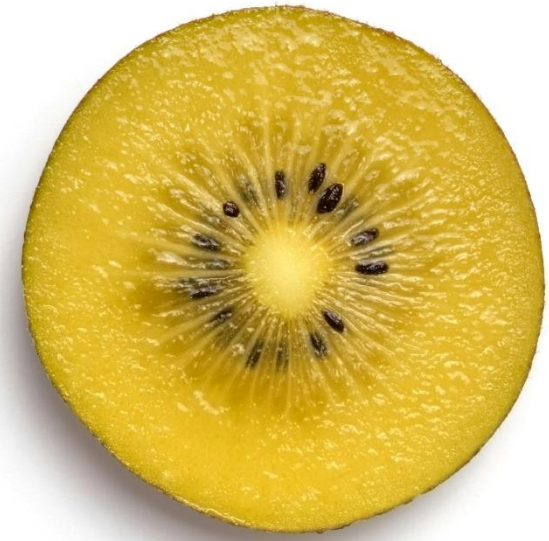
Nearly all of the kiwifruit grown in New Zealand is exported to various markets around the world (NZKGI, n.d.). By virtue of this, the use of international shipping freight is necessary for Zespri to deliver premium kiwifruit to the world and therefor the kiwifruit supply chain in New Zealand is heavily reliant on international carriers. Shipping makes up 43% of Zespri's scope 3 emission profile (Zespri, 2020), and is difficult to control. Over recent years, regulation has been changing rapidly for the international shipping environment as more impetus is placed on carbon emissions from trade activities globally (Iriarte et al., 2021). This has led to a reasonably

uncertain environment for shipping worldwide, as the sector becomes increasingly complex in the face of rapid regulation and technology change.

When deciding who to interview for this section, it was noted that Zespri already have an in-house team dedicated to shipping. This became the obvious choice, as the team were both accessible and knowledgeable. The interviewee was actively working in the shipping sustainability space, so was able to share insightful information for the benefit of the report.

5.4.2 Thematic analysis

From both the literature review and key interview, a thematic analysis was completed for the shipping segment of the kiwifruit supply chain, for kiwifruit grown in New Zealand. The results of the thematic analysis are outlined in Figure 6.



Photograph: unsplash.com

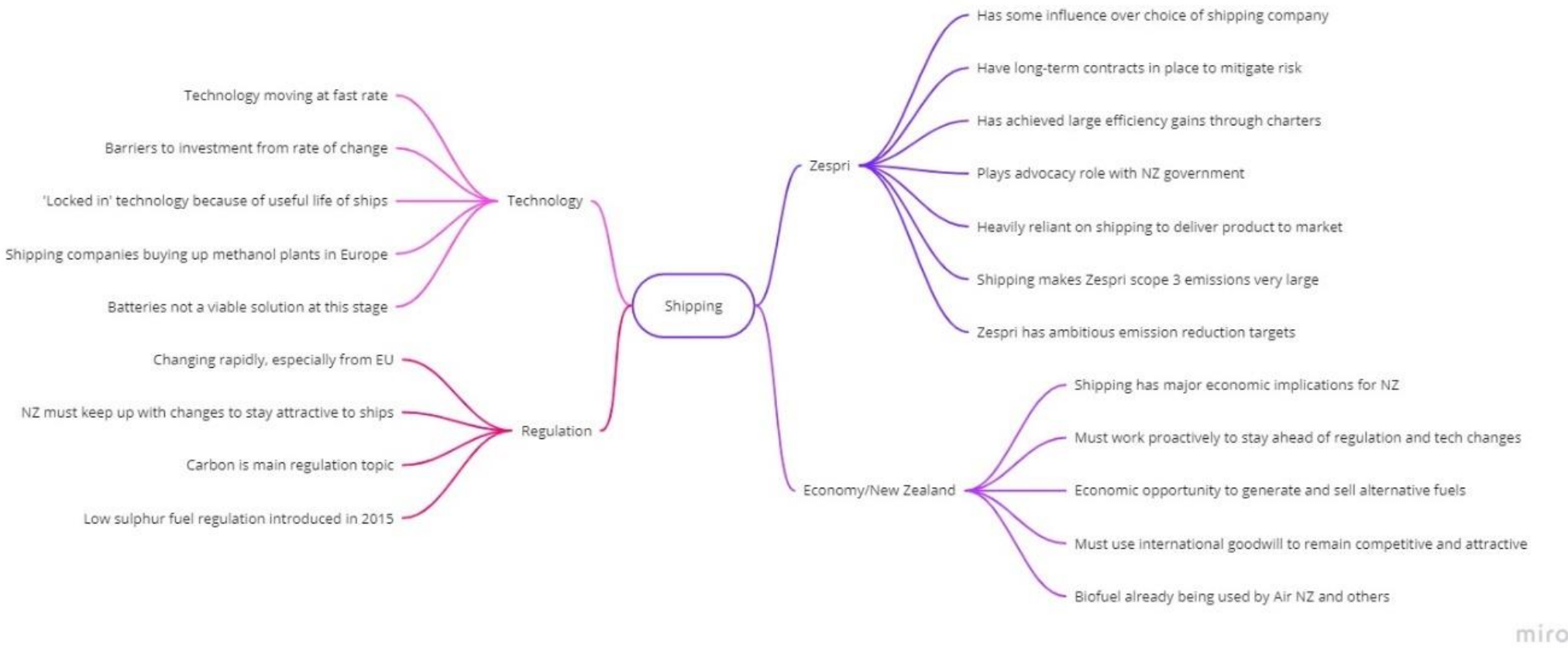


Figure 6 - Thematic Analysis Mind Map for Shipping in the Kiwifruit Supply Chain

5.4.3 Key Themes

The regulatory environment

The global regulatory landscape for the shipping industry is undergoing constant changes, particularly concerning CO2 emissions. Governments and trade blocs are revising their rules to encourage investment in low-emission shipping technologies and fuels, given the significant role of international shipping in global trade (Balcombe et al., 2019).

This shift has notable implications for the New Zealand kiwifruit supply chain, which relies entirely on shipping for exports. Zespri, as a company, tracks scope 1-3 emissions, including emissions from shipping, which accounts for 43% of the total emissions within the supply chain (Zespri, 2020). This aspect presents both substantial challenges and opportunities for the kiwifruit sector in terms of emissions reduction.

Despite being a major New Zealand company, Zespri's influence on international shipping regulations is limited due to its relatively small volume of trade on a global scale. Moreover, the carriers handling New Zealand kiwifruit shipments are international entities, making it difficult to impact decision-making in this context. In essence, Zespri and the New Zealand kiwifruit supply chain can strive to adapt to evolving international shipping regulations, such as emission reduction targets, to ensure the continued global shipment of kiwifruit from New Zealand.

The tyranny of distance

Given New Zealand's distance from its markets around the world, Zespri branded kiwifruit faces a challenge in keeping shipping companies interested in coming to our shores. Many of the ships that arrive at Tauranga Port to collect kiwifruit have come with empty containers. This means that the shipping company has paid for these containers to arrive in New Zealand, so the shipping companies are totally dependent on Zespri to make it worth their while on the return trip to market. This presents a huge risk for New Zealand grown kiwifruit, as it may come to a point where it is uneconomical to send empty containers to the bottom of the world if ships must pay vast amounts to compensate for emissions, or green shipping technology does not allow for this sort of range. This would not only impact kiwifruit grown in New Zealand, but all other primary exports that are reliant on international shipping to deliver their products to market.

"It's reasonably scary to think that if ships from the Northern Hemisphere decide to stop visiting New Zealand, what can we do to deliver our product to market?"

Technological change

The rate of change in shipping technology is the highest it has ever been. Once again, as the spotlight grows over the international shipping environment, companies are innovating and implementing technology as fast as possible to try and create a low emission alternative to fossil-fuel powered ships (Balcombe et al.,

2019). A major issue with this is the time and resource it takes to build these ships, as well as the useful life of a ship once it has been built. A container ship may take up to two-three years to build and is then generally in service for 25 years. Consequently, when a shipping company decides to build a new ship, they are essentially locking in that engine type and embedding that carbon for around 25 – 30 years. This has massive implications for new technology being implemented. Additionally, a new container ship costs many millions of dollars, so these are massive decisions. Despite these challenges, there are some key technologies being developed for green shipping alternatives as outlined below.

- LNG (Liquified Natural Gas)
- Methanol
- Hydrogen
- Wind technology
- Biofuels

Each of these systems possess different qualities and characteristics, suiting different types of vessels as well as challenges and costs associated. Although this report does not thoroughly explore these technologies in depth, they are outlined to illustrate what options are currently available.

Summary

Although there are options available for shipping to become more environmentally friendly, this landscape is complex and difficult due to the scale of the measures needing to be implemented. The economics of the transition to green shipping is further explored in Section 6 – Discussion.

5.5 Analysis Summary

In the analysis section, the report delved into emission reduction efforts within segments of the kiwifruit supply chain, including kiwifruit growers, post-harvest operators, Zespri, and shipping. Through in-depth interviews, it became evident that several initiatives are already in progress, and there's a consensus that these emission reduction endeavors should be sustained. What remained less clear was the effectiveness and economic ramifications of these initiatives, largely due to the duration of their implementation. As more data is gathered, it's expected that greater efficiency improvements will be achieved in emission reduction across each segment of the supply chain. Section 6 further explores the economic implications of these activities.

6. Discussion: Economic Implications Throughout the Supply Chain

The report conducts a comprehensive analysis of four integral elements of the New Zealand kiwifruit supply chain, primarily from the perspective of reducing GHG emissions. Throughout the supply chain, numerous initiatives are underway to align with governmental and international emissions reduction mandates. These endeavors exhibit variations in their effectiveness and associated costs. This section thoroughly examines the efficiency of these emission reduction measures within each segment of the supply chain, along with their economic implications.

6.1 The application of Eco-Efficiency throughout the supply chain

In addition to evaluating the effectiveness of emission reduction measures and their economic consequences, this report also investigates the implementation of EE within each context. This report quantifies EE as "Tonnes of CO2-e per $100,000 of Revenue" (examples below) and is acknowledged as a valuable tool for assessing both GHG emissions and economic impacts across these activities. Traditionally, EE is calculated inversely, using revenue as the numerator to gauge revenue efficiency. However, in this case CO2-e is chosen as the numerator and revenue as the denominator which yields a more tangible metric, emphasising emission efficiency rather than revenue-centric efficiency. The lower the final number, the more eco-efficient the supply chain is.

6.2 Kiwifruit Grower - Economic Implications of GHG Emission Reduction

Example Eco-Efficiency calculation

Tables 8 and 9 outline how the EE metric could be applied to both Zespri Sungold and Hayward kiwifruit orchards.

Table 8 – An Example of Eco-Efficiency on a Zespri Sungold Kiwifruit Orchard

Variety	Zespri Sungold
Total Hectares	5.0
Revenue / Hectare	$130,000
Total Revenue	$650,000
Tonnes CO2-e / Hectare	5.0
Total Tonnes CO2-e	25.0
Eco-Efficiency (Tonnes CO2-e/$100,000 revenue)	**3.846**

Table 9 - An Example of Eco-Efficiency on a Hayward Kiwifruit Orchard

Variety	Hayward
Total Hectares	5.0
Revenue / Hectare	$65,000
Total Revenue	$325,000
Tonnes CO2-e / Hectare	4.0
Total Tonnes CO2-e	20.0
Eco-Efficiency (Tonnes CO2-e/$100,000 revenue)	**6.154**

Economic Implications of GHG Emission Reduction on Orchard

Interview participants were also asked about the financial impacts of their emission reduction efforts. Table 10 outlines these financial impacts from interviewees in conjunction with the findings from the literature review.

Table 10 – Economic Implications of Emission Reduction Activities on Orchard

GHG Reduction Activity	GHG Reduction Impact	Investment /Cost-Saving	Payoff Scope	Economic Implication	Size of Economic Effect	Assumptions/ Comments
Technology adoption (i.e electrification)	Large	Investment	Medium	Benefit	Large	Emission calculations are assumed correct.
Fertiliser use	Medium	Cost-saving	Short	Benefit	Small	Depends on orchard size and fertiliser plan.
Spraying	Medium	Cost-saving	Short	Not yet certain	Small	Depends on orchard size and spray plan.
Mowing/mulching	Medium	Cost-saving	Short	Benefit	Medium	Depends on orchard size and mowing/mulching schedule.
Contractor use	Medium	Cost-saving	Short	Benefit	Medium	Depends on contractor use
Compost use	Medium	Cost-saving	Short	Not yet certain	Medium	Dependent on orchard size and fertiliser plan.
Ecosystem restoral	Low	Investment	Long	Not yet certain	Small	Depends on resources availability.
Waste and recycling	Low	Cost-saving	Medium	Benefit	Small	Depends on resources availability.
Embedded carbon (scope 3)	Medium	Neither	Long	Not yet certain	Neither	Indirect effects on profitability.

6.3 Post-harvest - Economic Implications of GHG Emission Reduction

Example Eco-Efficiency calculation

Table 11 outlines how the EE metric could be applied to a post-harvest operator in the kiwifruit supply chain.

Table 11 - An Example of Eco-Efficiency in a Kiwifruit Post-Harvest Facility

Revenue	$75,000,000
Total Tonnes CO2-e	4,875.0
Eco-Efficiency (Tonnes CO2-e/$100,000 revenue)	**6.5**

Economic Implications of GHG Emission Reduction at Post-harvest

Economic implications of emission reduction activities were also discussed during interviews with post-harvest operators. The outline of these implications, in conjunction with analysis from literature review is outlined in Table 12.

The analysis shows that many options are already available for post-harvest operators to reduce emissions immediately. For example, solar installation is an easy option for operators, with a large emission reduction impact and only medium-term payoff scope. Due to the potency of GHG gases from refrigerant leaks, investing in new cool store technology and leak detectors is another way to immediately reduce emissions, albeit with a potentially high upfront investment. Other cost-effective strategies to reduce emissions include LED light installation, electric vehicle upgrades and establishment of governance systems for emission reduction efforts.

Table 12 – Economic Implications of Emission Reduction Activities for Post-Harvest

GHG Reduction Activity	GHG Reduction Impact	Investment/ Cost-Saving	Payoff Scope	Economic Implication	Size of Economic Effect	Assumptions/ Comments
Solar installation	Large	Investment	Medium	Benefit	Large	Outcome depends on sophistication of energy use (i.e selling energy back to grid).
Energy efficiency	Medium	Cost-saving	Short	Benefit	Medium	Depends on availability and generation source of energy.
Refrigerant leak management	Large	Cost-saving	Medium	Benefit	Small	Depends on type of management. If investing in new cool stores, economic cost is large.
Waste management	Small	Cost-saving	Short	Not yet certain	Medium	This row assumes an efficient waste management operation.
LED light upgrades	Small	Cost-saving	Short	Benefit	Small	This is relatively easy to achieve.
Electric/Hybrid vehicles	Medium	Investment	Short	Benefit	Medium	Dependent on both electricity source and price.
Scope 3 emission reduction	Large	Neutral	Long	Benefit	Large	Ability to influence large change.
Governance	Medium	Investment	Medium	Benefit	Medium	Depends on experience and governance available.

6.4 Zespri - Economic Implications of GHG Emission Reduction

Given Zespri's unique position in the kiwifruit supply chain, the economic implications of emission reduction activities are harder to quantify. This is because a large part of their role in GHG emission reduction comes through influence, from the likes of education across the industry as well as investment into innovation, new cultivars and technology which may not have an immediate or measurable impact. It is well known that Zespri have invested considerably into GHG emission reduction over the last decade, by building a sustainability team, measuring their carbon footprint, investing in new cultivars, purchasing hybrid and electric vehicles as well as increasing efficiency in electricity consumption among other activities. For Zespri, it is paramount that considerable effort goes into GHG emission reduction, to retain market access around the world as well as building new markets as discussed in the analysis section. On this basis, the economic implications of emission reduction activities are significant for Zespri, given that in the European Union for example, there may be no market if New Zealand grown kiwifruit does not meet the Paris Climate Accord obligations.

Example Eco-Efficiency calculation

Table 13 outlines how the EE metric could be applied to the Zespri Corporate.

Table 13 – An Example of Eco-Efficiency used in a Zespri Context

Revenue	$3,920,000,000
Total Tonnes CO2-e (scope 1-3)	309,000
Eco-Efficiency (Tonnes CO2-e/$100,000 revenue)	**7.88**

6.5 Shipping - Economic Implications of GHG Emission Reduction

The role of the international shipping industry in shaping the future emissions profile of Zespri branded kiwifruit cannot be understated. It not only constitutes a significant portion of the overall emissions but also serves as a lifeline for the industry, facilitating the delivery of goods to global markets and contributing to the economic prosperity of New Zealand. Given this context, the New Zealand kiwifruit sector must take a proactive stance, in collaboration with the New Zealand government and other sectors, to remain at the forefront of the transition toward low-emission shipping practices.

During a key interview, an avenue for investment was highlighted, one that could benefit New Zealand with Zespri at the forefront. This opportunity involves the investment in biofuel generation, a sustainable alternative to traditional fossil fuels for existing ships. Biofuels present an appealing proposition for shipping companies as they can replace conventional fuels without the need for substantial capital investments in new technology. Biofuels are derived from organic matter, often biomass, and their production involves the absorption of CO2 from the atmosphere during the growth of the source material. This characteristic offers the potential for biofuels to be carbon-neutral when consumed, as highlighted in the article by Maritime Impact, (2023).

The economic prospects for New Zealand in pursuing biofuel generation are significant:

1. Abundant Biomass Resources: New Zealand possesses substantial quantities of biomass resources, including forestry waste, farming byproducts, and other organic matter that undergoes natural degradation and remains underutilised. These resources can be harnessed for biofuel production, reducing waste, and offering economic benefits.

2. Attracting Shipping Companies: As the shipping sector faces increasing scrutiny for its greenhouse gas emissions, shipping companies may become more selective in their routes. The availability of biofuels in New Zealand could act as an attractive incentive for companies, particularly those with long-distance routes to the country.

3. Diversification into Green Technology: By investing in biofuel generation, New Zealand has the opportunity to diversify its industries into green technology, tapping into the growing global demand for sustainable energy sources.

The broader implications for the New Zealand kiwifruit industry concerning the transition to green shipping technologies are substantial. The sector potentially faces significant economic challenges, as global shipping comes under more stringent emission regulations and as the cost of fossil fuels continues to rise. Companies may become less inclined to travel to New Zealand, especially when returning with empty containers, which could have a detrimental impact on the industry.

However, the New Zealand kiwifruit industry, in conjunction with other sectors, has the opportunity to co-invest in or collaborate with shipping companies to navigate these challenges effectively. By adopting and advocating for green shipping practices and biofuel adoption, the industry can mitigate the risks and ensure the long-term sustainability and prosperity of the kiwifruit sector. This proactive approach aligns with the industry's commitment to reducing emissions and promoting a sustainable future, both environmentally and economically.

7. Conclusions

The comprehensive analysis of the New Zealand kiwifruit supply chain's greenhouse gas (GHG) emission reduction efforts and economic implications reveals a complex landscape. The report has investigated four key segments of the supply chain; growers, post-harvest, Zespri, and shipping, shedding light on the strategies employed to mitigate emissions and meet governmental and international market requirements.

One important aspect of the analysis is the application of eco-efficiency as a metric to assess both GHG emissions and economic implications. Traditionally, eco-efficiency is measured with revenue as the numerator, but in this context, the report suggests using CO2-e as the numerator, providing a more quantifiable target for emission reduction.

The report provides eco-efficiency calculations for both Zespri Sungold and Hayward kiwifruit, as well as the post-harvest segment of the supply chain. The results show potential varying levels of efficiency, with each variety presenting its unique challenges and opportunities for reducing emissions. The economic implications for both growers and post-harvest are explored in terms of different emission reduction activities, such as technology adoption, fertiliser use, electric vehicles, refrigerant leak management and waste management. These activities carry different levels of GHG reduction, costs, and payoffs, depending on the circumstance of each entity.

Zespri invests in GHG emission reduction initiatives. Its economic implications are harder to quantify, as many of these efforts revolve around influencing industry practices, education, and innovation. However, the report emphasises that Zespri's commitment to reducing emissions is paramount for maintaining access to global markets and aligning with international climate obligations. As part of Zespri's scope 3 emissions, the international shipping aspect of the supply chain is crucial, contributing significantly to GHG emissions. The report highlights the importance of proactive measures in transitioning to low-emission shipping. Biofuel generation is suggested, as it can serve as a drop-in alternative to fossil fuels, offering carbon-neutral options for existing ships. The economic opportunity for New Zealand in investing in biofuels and green shipping technologies is also discussed.

In conclusion, the analysis of the New Zealand kiwifruit supply chain's GHG emission reduction efforts and their economic implications underscores the complexity of balancing environmental sustainability with economic considerations. Different segments of the supply chain employ various strategies to reduce emissions, with each having its unique set of challenges and opportunities. As global markets and governments increasingly prioritise sustainability and emissions reductions, the New Zealand kiwifruit industry must remain proactive and adaptable to secure its future economic prosperity. Collaboration, innovation, and investment are critical factors that can help mitigate the economic risks associated with transitioning to a low-carbon, sustainable supply chain while ensuring the longevity of this vital industry.

8. Recommendations

1. Industry Advisory Council (IAC) to introduce eco-efficiency across the supply chain

The following steps are suggested:

- **Standardised Reporting**: Encourage all stakeholders to report "Tonnes CO2-e / $100,000 revenue."

- **Benchmark Targets**: Establish eco-efficiency targets for each supply chain segment. For example:
    - No more than 2 Tonnes CO2-e / $100,000 revenue for Sungold Kiwifruit Orchards by 2030.
    - No more than 3 Tonnes CO2-e / $100,000 revenue for Hayward Kiwifruit Orchards by 2030.
    - No more than 3 Tonnes CO2-e / $100,000 revenue for Post-Harvest Operators by 2030.
    - No more than 5 Tonnes CO2-e / $100,000 revenue for Zespri Corporate (including shipping) by 2030.

- **Gradual Reduction Targets:** Gradually reduce these targets over time to drive emissions down while boosting revenue, promoting ongoing efficiency and sustainability.

2. Zespri to adjust the grower Carbon Neutral Trial

The Carbon Neutral Trial (CNT) can be made more effective through improved communication with growers and the inclusion of eco-efficiency measures. Enhancements to the CNT program include:

- Improved Communication: Provide clearer information to growers about the trial's purpose, such as market access requirements, goals, and targets for emission reduction, and updates on technology development.

- Incorporate Eco-Efficiency: Include EE metrics within the CNT to align with the standardised measure recommended for the entire supply chain.

3. The kiwifruit industry to invest into green shipping collaboration

Recognising the kiwifruit industry's heavy reliance on shipping for product delivery, proactive steps are essential to address the transition to green shipping. Recommendations include:

- **Green Shipping Council:** Zespri, in conjunction with MFAT and MPI to establish a Green Shipping Council in New Zealand, comprising stakeholders from various export industries, to collaborate on adopting sustainable shipping practices.

- **Advocacy for Research and Development:** The New Zealand kiwifruit industry to advocate to the New Zealand Government for research and development into clean fuel technologies, including biofuel options for the shipping sector.

- **Biofuel Investment Council:** Set up a Biofuel Investment Council to explore the economic and resilience opportunities of producing biofuels in New Zealand, particularly utilising the country's substantial biomass resources.

4. Trade negotiators and NZKGI to advocate internationally

To maximize the value and economic prosperity stemming from GHG emission reduction efforts within the New Zealand kiwifruit industry, it is crucial to engage at the international level. Key recommendations for international advocacy include:

- **Active Industry Advocacy:** Industry groups and stakeholders, such as NZKGI, should encourage Zespri and industry bodies to play an active role in advocating for kiwifruit stakeholders' emission reduction initiatives on the global stage**.**

- **Educate Trade Negotiators:** NZGKI should ensure that trade negotiators are well-informed about the industry's emission reduction endeavors, helping them to advocate for favourable terms and market access.

- **Regular Reporting:** Implement a system for regular reporting on emission reduction progress and initiatives, which can serve as valuable market feedback and increase transparency.

These recommendations collectively aim to create a more sustainable, collaborative, and profitable kiwifruit supply chain in New Zealand. By introducing standardised eco-efficiency metrics, enhancing the Carbon Neutral Trial, addressing green shipping challenges, and engaging internationally, the industry can reduce its carbon footprint and promote economic growth while adhering to global environmental standards.

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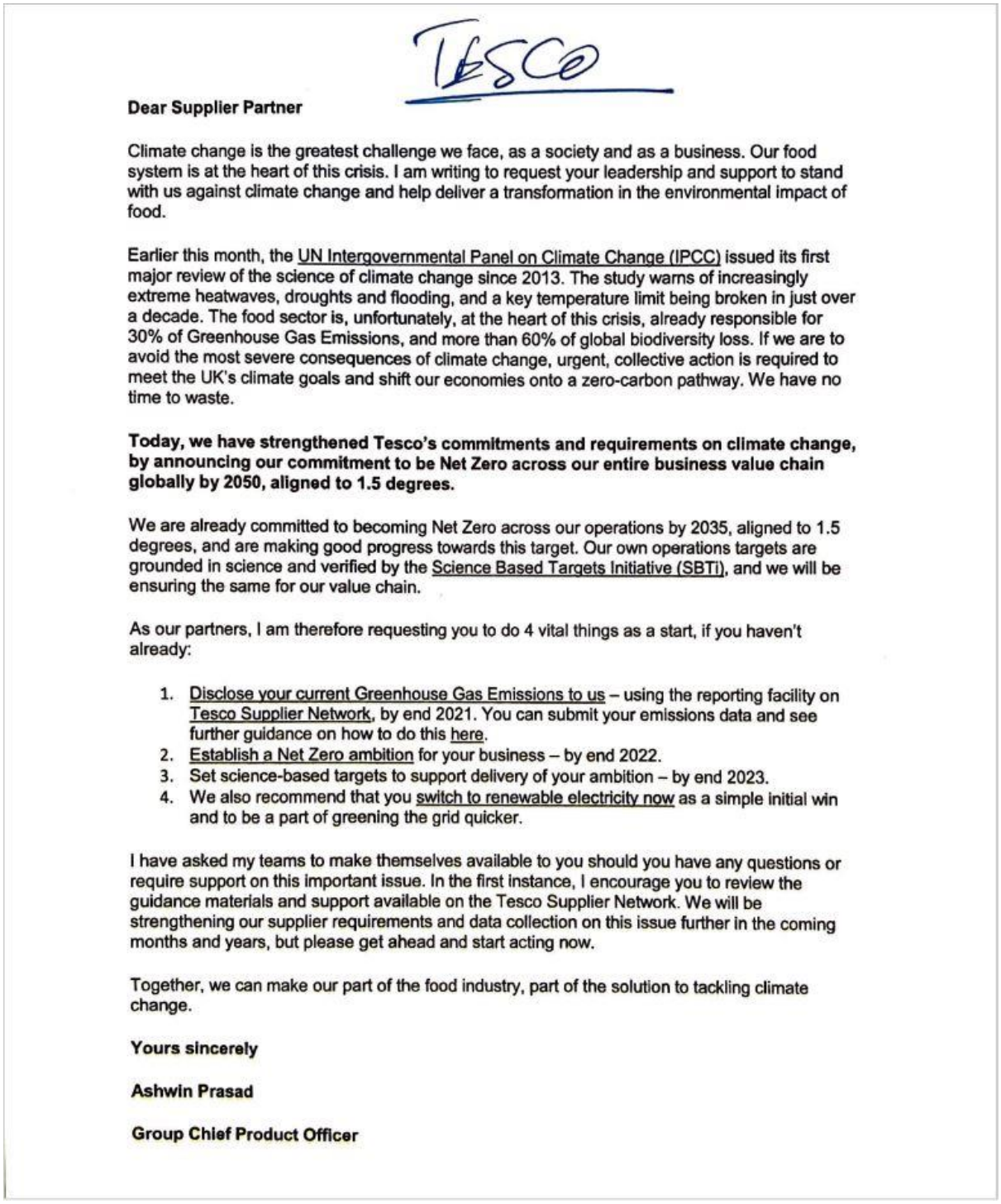
10. Appendices

Appendix 1 – Letter from Tesco's outlining Emission Reduction Requirements



Tesco

Dear Supplier Partner

Climate change is the greatest challenge we face, as a society and as a business. Our food system is at the heart of this crisis. I am writing to request your leadership and support to stand with us against climate change and help deliver a transformation in the environmental impact of food.

Earlier this month, the UN Intergovernmental Panel on Climate Change (IPCC) issued its first major review of the science of climate change since 2013. The study warns of increasingly extreme heatwaves, droughts and flooding, and a key temperature limit being broken in just over a decade. The food sector is, unfortunately, at the heart of this crisis, already responsible for 30% of Greenhouse Gas Emissions, and more than 60% of global biodiversity loss. If we are to avoid the most severe consequences of climate change, urgent, collective action is required to meet the UK's climate goals and shift our economies onto a zero-carbon pathway. We have no time to waste.

Today, we have strengthened Tesco's commitments and requirements on climate change, by announcing our commitment to be Net Zero across our entire business value chain globally by 2050, aligned to 1.5 degrees.

We are already committed to becoming Net Zero across our operations by 2035, aligned to 1.5 degrees, and are making good progress towards this target. Our own operations targets are grounded in science and verified by the Science Based Targets Initiative (SBTi), and we will be ensuring the same for our value chain.

As our partners, I am therefore requesting you to do 4 vital things as a start, if you haven't already:

1. Disclose your current Greenhouse Gas Emissions to us – using the reporting facility on Tesco Supplier Network, by end 2021. You can submit your emissions data and see further guidance on how to do this here.
2. Establish a Net Zero ambition for your business – by end 2022.
3. Set science-based targets to support delivery of your ambition – by end 2023.
4. We also recommend that you switch to renewable electricity now as a simple initial win and to be a part of greening the grid quicker.

I have asked my teams to make themselves available to you should you have any questions or require support on this important issue. In the first instance, I encourage you to review the guidance materials and support available on the Tesco Supplier Network. We will be strengthening our supplier requirements and data collection on this issue further in the coming months and years, but please get ahead and start acting now.

Together, we can make our part of the food industry, part of the solution to tackling climate change.

Yours sincerely

Ashwin Prasad

Group Chief Product Officer

Appendix 2 – Interview Questions for Kiwifruit Growers

1. What are the main areas of emission reduction on orchard?

2. What has seen the most successful emission reduction out of these areas?

3. How do you see the on-orchard emission reduction regulation changing in the next 5-20 years?

4. Has there been any drawbacks from implementing these practices on orchard?

5. Any other information or material you'd like to share?

Appendix 3 – Interview Questions for Post-harvest Representatives

1. What kind of measures has your company put in place to reduce GHG emissions on site?

2. What are some of the results you've seen from implementing these practices, both
a) Positive
b) Negative

3. What are the
   a) costs of and,
   b) savings from implementing GHG reduction measures?

4. In the medium to long term (5 – 50 years), what do you think are the benefits and drawbacks from implementing these practices?

5. How do you see the GHG regulatory environment changing for kiwifruit packhouses in the next 10-20 years?

6. Have you taken part in the carbon neutral trial as a packhouse? If so, are you able to share any of the results?

7. Has there been any analysis done on the carbon embedded in your packaging?

8. Do you have any other comments or materials you'd like to share?

Appendix 4 – Interview Questions for Zespri

1. How is Zespri looking to invest in GHG reduction over the next 10 – 20 years?

2. How do you see the GHG regulatory environment changing for Zespri in the next 10 – 20 years?

3. What resource has Zespri put into GHG reduction over the last 5 years

4. Do you see a positive tipping point coming?

5. Have you seen or witnessed any market impacts on kiwifruit exported from NZ due to our environmental status?

6. What do you see as the biggest opportunities for Zespri regarding GHD reduction?

Appendix 5 – Interview Questions for Zespri – Shipping

1. Can you please explain your role at Zespri for me?

2. What role does Zespri play in influencing shipping decisions for its fruit?

3. How would you explain the shipping situation, for Zespri kiwifruit, from a GHG emission perspective?

4. From an emission reduction perspective, what are the biggest changes you've seen in shipping over the last five years?

5. What are the challenges you foresee in converting to clean technologies in shipping?

6. What are the economic opportunities you see in reducing emissions in shipping?

7. How do you see the regulatory environment changing for the shipping environment out of New Zealand in the next 10 years?

8. Any other comments?

Appendix 6 – Interview Questions for Ministry of Primary Industries

1. How does MPI interact with MFAT, and which ministry would have more influence on the trading environment for New Zealand grown kiwifruit?

2. How much of an influence do you think market led demand (i.e. Tescos in UK) will have on our horticultural exports from New Zealand, as opposed to domestic policy?

3. How will New Zealand's international trade agreements be effected by our Paris Climate Accord obligations?

4. During international trade negotiations, what are the main points of conversation regarding New Zealand primary exports around the world?

5. Will kiwifruit be treated any different to other primary exports out of NZ?

6. Any further comments?