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The Land and the Brand

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Report prepared for

AGMARDT
THE AGRICULTURAL AND MARKETING RESEARCH AND DEVELOPMENT TRUST

ANZCO FOODS

beef+lamb new zealand

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Research Report
No. 339
March 2016

Lincoln University
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Suggested citation for this report:

Saunders, Caroline, Paul Dalziel, Meike Guenther, John Saunders and Paul Rutherford (2016). *The Land and the Brand*. AERU Research Report No. 339, prepared for AGMARDT, ANZCO Foods, Beef and Lamb New Zealand, Fonterra and Zespri. Lincoln University: Agribusiness and Economics Research Unit.

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ISSN 1170-7682 (Print)
ISSN 2230-3197 (Online)
ISBN 978-1-877519-44-4

Acknowledgements

This project was overseen by an advisory board comprised of Sir Graeme Harrison (chairperson), Hugh Bigsby, Rob Davison, Nick Kirton, Alan McDermott, Ben O'Brien, Emma Parsons, Earl Rattray and Stefanie Rixecker. The authors thank all of these people for the time they committed to this research and for their very helpful feedback at key stages of the research. We are also grateful to Geoff Butcher for providing data and advice used in the preparation of Figure 2-5 and Figure 2-6. In publishing this report, the authors are pleased to acknowledge generous funding from AGMARDT, ANZCO, Beef+Lamb, Fonterra and ZESPRI with in-house support from Lincoln University. We emphasise, however, that the contents of this report are based on our own independent, professional judgements and should not be attributed to Lincoln University or any of our external funding organisations.

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Executive Summary

1. Introduction

The Agribusiness and Economics Research Unit at Lincoln University was commissioned to prepare this report assessing the contributions that the agri-food sector has made to the wellbeing of New Zealanders over the decades and in the present day. The purpose of this research is to indicate how industry-led initiatives and private-public partnerships might build on the sector's historical successes for ongoing economic prosperity into the future.

The agri-food sector continues to dominate the country's merchandise exports. The dairy sector in 2013/14 generated export revenue of just over $18 billion, followed by meat and wool (more than $8 billion), forestry (more than $5.1 billion), horticulture (nearly $3.8 billion) and seafood (more than $1.7 billion).

2. Where We Are Today

The agri-food sector makes substantial direct and indirect contributions to the level of economic activity within New Zealand. In 2011/12, agri-food primary production accounted directly for $13 billion of value added in the national economy and agri-food processing accounted directly for another $12 billion. The combined total of $25 billion represented 12 per cent of gross domestic product. The indirect contributions through purchases of inputs from other parts of the economy in 2011/12 amounted to another $15 billion, bringing the total share of the national economy to 19 per cent.

Thus, for every $5 of value created in the economy each year, just under $1 is due directly or indirectly to the agri-food industries.

Data from the 2013 Census recorded just under 10,000 people employed in the agri-food primary and processing industries. This workforce has a lower level of qualifications than the general workforce, suggesting there may be further opportunities for skill-based increases in labour productivity throughout the sector. There is also potential for greater contributions from the sector towards the country's social and environmental objectives.

3. How We Got Here

The history of the country's agri-food production, processing and exporting is replete with examples of New Zealand enterprise creating and capturing value through the interaction of four key elements:

- changes in international trade;
- developments in domestic industries and policies;
- innovations in science and technology; and
- creations of trusted commercial brands.

These elements were evident in the adaption of overseas technologies by the first Māori and European settlers and then the shift in exports from wool to meat and dairy following the first shipment of refrigerated meat to the United Kingdom in 1882. The Ottawa Agreement signed in 1932 cemented New Zealand's trading relationship with the United Kingdom until the end of bulk purchase agreements with that country in 1954. This led to greater diversification of trading partners and of traded products from the middle of the twentieth century, reinforced by the impact of domestic economic reform after 1984.

4. Our Trading Environment is Changing

The international trading environment continues to change. Four trends in global markets are currently affecting New Zealand producers and processors: (1) growth in global agricultural production; (2) increased market segmentation and consumer targeting; (3) greater trade liberalisation in agri-food products; and (4) biosecurity threats to agri-food production. These developments are leading to changes in consumption, production and trade patterns in New Zealand and elsewhere. They therefore present potential opportunities but also challenges for New Zealand's land based sectors.

Even in products where New Zealand has a large share of international trade (some dairy products such as whole milk powder, for example), it has only a very small share of global production. Consequently, it is sensible for New Zealand exporters to target international consumers who put the highest value on attributes associated with New Zealand produce. These attributes include obvious physical features such as appearance, taste and texture, but also what are termed credence attributes of the product (such as food safety, nutritional value, GM-free, and specific health benefits) or its production system (such as animal welfare, environmental protection, social wellbeing and cultural authenticity).

5. Where We Might Go Next

The Lincoln Trade and Environment Model (LTEM) was used to analyse possible Futures given current trends in international trade. The period of analysis was for the decade 2015 to 2024. Even on base projections drawn from official international data sources (Future 1), the analysis indicates increases in New Zealand net exports of beef, sheep meat, butter, cheese, whole milk powder and skim milk powder, suggesting growth in producer returns of about one-third (for beef producers) or one-quarter (for sheep meat producers and raw milk producers).

Future 2 analyses the impact of reductions in total tariffs, duties, and market support for all modelled agricultural commodities in all countries of LTEM. A range of reductions is addressed, from 25 to 100 per cent. This shows that trade liberalisation has the potential to significantly increase the net trade value for all the examined commodities, increasing the more trade barriers are relaxed. Compared to the base scenario, for example, total dairy net trade for New Zealand increases by US$3.6 billion under 100 per cent reductions in barriers.

Future 3 is based on the well-established observation that market segmentation and consumer targeting can deliver greater value to final purchasers, generating a price premium throughout a value chain. Based on this observation, Future 3 analyses the impacts of two scenarios if New Zealand achieved a premium of 20 per cent or 50 per cent respectively in

seven developed countries (Australia, Canada, Europe Union (28), Korea, Japan, and the United States of America) and three developing countries (China, India, and Indonesia). The increase in net trade beyond that achieved in the base scenario for all selected products is about US$2.1 billion in the first scenario and about US$5.5 billion in the second scenario. Even in the first scenario, the modelled increase in returns to beef and sheep meat producers is more than 20 per cent and is 10 per cent for raw milk producers.

Future 4 combines Future 2 (assuming 100 per cent reductions in trade barriers) and Future 3 (assuming price premiums of 20 per cent and 50 per cent in two different scenarios). This produces the biggest increases in net trade and returns. Complete trade liberalisation plus a 20 per cent price premium results in an almost 50 per cent increase for total dairy net trade, a US$5.3 billion shift beyond the base scenario. This increases to US$7.8 billion with a 50 per cent premium. Trade in beef and sheep meat is modelled to rise above the base scenario by more than 50 per cent and 100 per cent respectively with a 20 and 50 per cent premium. The modelled increases in producer returns almost double for beef and sheep meat producers under the second of the two scenarios, while the returns to dairy producers increase by almost two-thirds (worth approximately US$8 billion).

Finally, Future 5 considers biosecurity threats to agri-food production in New Zealand, paying particular attention to the impact of an outbreak of foot and mouth disease under two scenarios. In both scenarios, there is a loss of production while the outbreak is controlled. The first scenario assumes only a limited loss of access to international markets as a consequence of the outbreak; in the second scenario the market reaction is assumed to be strongly negative with market access taking a decade to be restored. In both scenarios there are substantial costs as a result of a major outbreak of the disease. In the first scenario, the loss is US$25 billion; this increases to nearly US$50 billion in the second scenario as a result of enduring trade sanctions against New Zealand exports.

6. Conclusion: The Land and the Brand

The results in this report suggest that the agri-food sector will continue to play a dominant role in the New Zealand economy over the next decade if it succeeds in maximising value creation through integrating domestic industry developments, science and technology innovation and trusted commercial brand creation in the new international trading environment. The authors suggest six aspects that we argue would facilitate the sector's growth:

- the importance of industry leadership;
- private-public partnerships;
- effective science and innovation systems;
- market awareness,
- responsive skills development ecosystems; and
- cooperative investment to support value chain enhancements.

The importance of industry leadership comes from the key role that consumer targeting plays in capturing increased value for New Zealand produce; industry know their customers best and are therefore best placed to initiate efforts for providing value that can attract a premium

for quality. Nevertheless, there are aspects of value creation and value communication that can only be achieved through private-public partnerships. The ongoing roles of the government in biosecurity and negotiating greater trade liberalisation are obvious examples, but there are also public good characteristics in each of the above components.

The report documents how science-driven innovation has always been an essential part of the New Zealand's agri-food sector. This will continue into the future, with a stronger focus on commerce-based research to supplement the ongoing ecological and life sciences research in the country's universities and Crown Research Institutes. This report finishes with five examples where greater research effort will contribute to further development:

- the New Zealand story;
- engagement with citizens;
- international trade liberalisation;
- responsive systems for skills development; and
- capturing value chain opportunities.

The title of this report is *The Land and the Brand*, which expresses the core theme of its contents: In globalised markets, commercial success requires a combination of quality production systems ("*The Land*") and quality consumer perceptions ("*The Brand*"). Internationally, New Zealand has strong competitive advantages in its land and in its brands, but the report offers a vision for how research and development will improve both aspects of this combination to create new opportunities for New Zealand agri-food exporters.

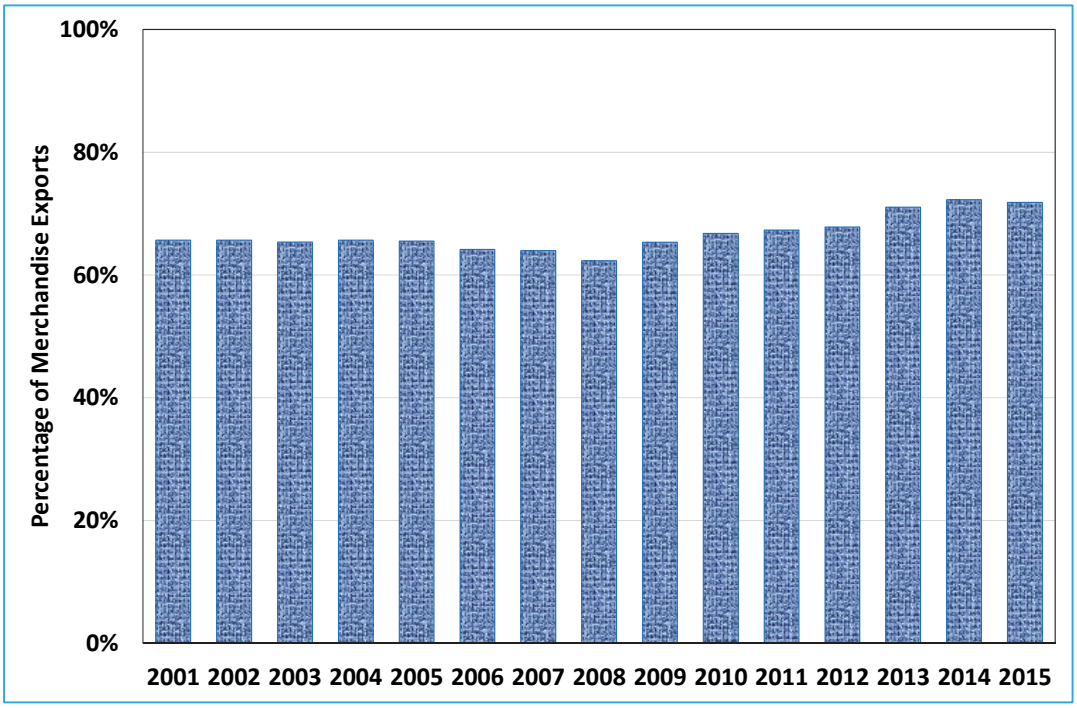
Consistent with that vision, the New Zealand agri-food sector will continue to be at the heart of science-led development of the country's national and regional economies.

1. Introduction

1.1 Background to this Report

New Zealand is a small country whose economic prosperity depends on its ability to export locally produced goods and services in order to pay for imported goods and services that are produced in other countries. Since the early days of European settlement when wool made up 90 per cent of the country's exports to the current day where dairy products represent nearly a third of total merchandise exports, the agri-food sector has an impressive record in contributing to the standard of living achieved in New Zealand. Despite that record, recent policy initiatives such as the Knowledge Wave, the Growth and Innovation Framework and the Economic Transformation Agenda have tended to focus on other aspects of the economy. As demonstrated in Figure 1-1, however, these policies could not counter the underlying market advantages of the agri-food sector. Despite deliberate policies to promote other sectors, the agri-food sector's share of the country's merchandise exports remained stable (apart from the impact of the nationwide drought between spring 2007 and autumn 2008, and has risen in recent years to be just under 72 per cent in 2015.

Figure 1-1: Agri-Food Share of Merchandise Exports, 2001-2015



Source: Statistics New Zealand *NZ.Stat*, Exports for Overseas Merchandise Trade.

The recent increase is due, at least in part, to global events that have created unprecedented opportunities for New Zealand's primary sector exporters. This includes the advantage New Zealand achieved by being one of China's first OECD trading partners with a Free Trade Agreement and with a capacity to meet that country's growing demand for whole milk powder. It is also due, again at least in part, to the ability of New Zealand exporters to attract price premiums for the quality of some of its agri-food produce into high income markets.

There nevertheless remains an influential view that New Zealand should "get off the grass". This is the title of a recent book by Shaun Hendy and the late Sir Paul Callaghan, which argued for "deliberate steps to break [the] economic dependence on the primary sector, in particular by investing in science and technology" (Hendy and Callaghan, 2013, pp. 15-16). That comment suggests there is a contrast between the primary sector and investing in science and technology. As later sections of this report will document, this is a false dichotomy: science-driven innovation has always been an essential part of the agri-food sector's growth.

Against that background, the Agribusiness and Economics Research Unit (AERU) at Lincoln University was commissioned to prepare this report assessing the contributions that the agri-food sector has made to the wellbeing of New Zealanders over the decades and in the present day. The AERU was asked to explore the underlying reasons for New Zealand's demonstrated success in its agri-food industries and to analyse current trends affecting the sector (including potential changes in the country's international trading opportunities and possible implications of environmental impacts of production). The purpose of this research is to indicate how industry-led initiatives and private-public partnerships might build on the sector's historical successes for ongoing economic prosperity into the future.

Our core theme can be explained in a single paragraph. New Zealand's agri-food industries have been successful because they have been able to create additional value on an ongoing basis through the integration of four elements:

- Changes in international trade;
- Developments in domestic industries and policies;
- Innovations in science and technology; and
- Creations of trusted commercial brands.

As the international trade environment for agri-food exports continues to change, value creation will require further domestic industry and policy development, further science and technology innovation, and further commercial brand creation. The country's agri-food sector can add value in its exports – and reduce its reliance on commodity markets and their associated price cycles – through ongoing cooperative investment in industry leadership, in value-protecting private-public partnerships, in effective science and innovation systems, in responsive skills development ecosystems, and in value chain enhancements.

1.2 Definition of the Agri-Food Sector

A feature of the New Zealand economy is the relative importance of products that are created from deliberately cultivated or managed natural resources. A common collective name used to describe these products as a group is "agri-food" which is the term generally used throughout this report. The agri-food sector can be further categorised into different industries. The Ministry for Primary Industries, for example, publishes a regular outlook that distinguishes six primary industries, listed in Table 1-1.

Table 1-1: Primary Industry Export Revenue, Year Ending June 2014

		Export Revenue 2013/14 (NZ$ million)
Primary Industries	**Dairy**	18,068
	Meat and Wool	8,093
	Forestry	5,144
	Horticulture	3,786
	Seafood	1,427
	Other	1,787
	Total	**38,305**

Source: Ministry for Primary Industries (2015, p. 4).

The dairy industry is the largest industry by export revenue, contributing just under one-half of the primary industries defined by the Ministry. The largest New Zealand manufacturer of diary produce by a considerable amount is Fonterra, with sizeable amounts also produced by Open Country Dairy, Westland Milk Products, Synlait and Tatua Co-operative (Scrimgeour, 2014, p. 75).

The next largest industry is the meat and wool industry. There are four major companies in the New Zealand red meat industry, which account for approximately three-quarters of the market: Silver Fern Farms; Alliance; AFFCO; and ANZCO (Crofoot, 2014, p. 81). There have been significant changes in the pattern of wool exports over the decades; in 1990/91, for example, China accounted for 10 per cent of New Zealand wool exports, but by 2013/14, this figure had increased to 52 per cent (Davison, 2014, p. 95).

The forestry industry exports around 44% of harvested logs, with Australia, China, India, Indonesia, Japan, Korea and the United States accounting for more than 80 per cent of the value of these exports (Forest Owners Association, 2015). Horticulture exports are dominated by fruit products. Significant enterprises in this industry include ZESPRI (formerly the New Zealand Kiwifruit Marketing Board) and ENZA and Frucor (formerly parts of the New Zealand Apple and Pear Marketing Board).

The animal materials industry covers live animals, hides and skins, textile fibres (processed and unprocessed) and other materials of animal origin. The most important textile fibre export from New Zealand is wool.

The final industry in Table 1-1 is the seafood industry. This is not a land-based industry, but it shares the important characteristic of a deliberately managed natural resource that plays an essential part in New Zealand's export-led economic prosperity. New Zealand has the world's fourth-largest exclusive economic zone for its managed fisheries, based on the international standard of a 200 nautical mile limit. These fisheries are controlled using New Zealand's quota management system.

Table 1-1 is based on definitions used by the Ministry for Primary Industries for its regular outlook series. Different sources categorise the relevant data in different ways, indicating slightly different measures. This report aims to use official sources to provide a consistent account of the agri-food sector, but will make allowances for different approaches dependent on what data are available. None of these adjustments are material to the analysis in this report.

1.3 Structure of the Report

Chapter 2 examines where the agri-food sector is today. It presents an overview of the agri-food industries in the New Zealand economy to demonstrate their ongoing importance for the country's economic wellbeing. The presentation is built on official sources of statistical data for the previous ten years, covering the standard triple bottom line framework of economic, social and environmental data.

Chapter 3 reviews historical events and time periods important for the development of New Zealand's agri-food industries. The chapter focuses on the way in which the following four elements have interacted over the decades to create additional value in these industries on an ongoing basis: (a) changes in international trade; (b) developments in domestic industries; (c) innovations in science and technology; and (d) creations of trusted commercial brands.

Chapter 4 discusses four key trends in the global economy that are affecting New Zealand producers and processors. The four trends are: (1) growth in global agricultural production; (2) increased market segmentation and consumer targeting; (3) movements towards greater trade liberalisation in agri-food products; and (4) an expanding range of biosecurity threats to agri-food production.

Chapter 5 uses the Lincoln Trade and Environment Model to analyse the implications of the four trends identified in chapter 4. The analysis confirms some long-standing policy positions in New Zealand; most notably, the importance of liberalising world trade in agri-food products and the importance of biosecurity to protect New Zealand producer returns. The chapter indicates that significant increases in returns to producers of beef, sheep meat and raw milk are possible over the next decade, particularly if market segmentation and consumer targeting can achieve price premiums in an increasingly liberal international trading environment.

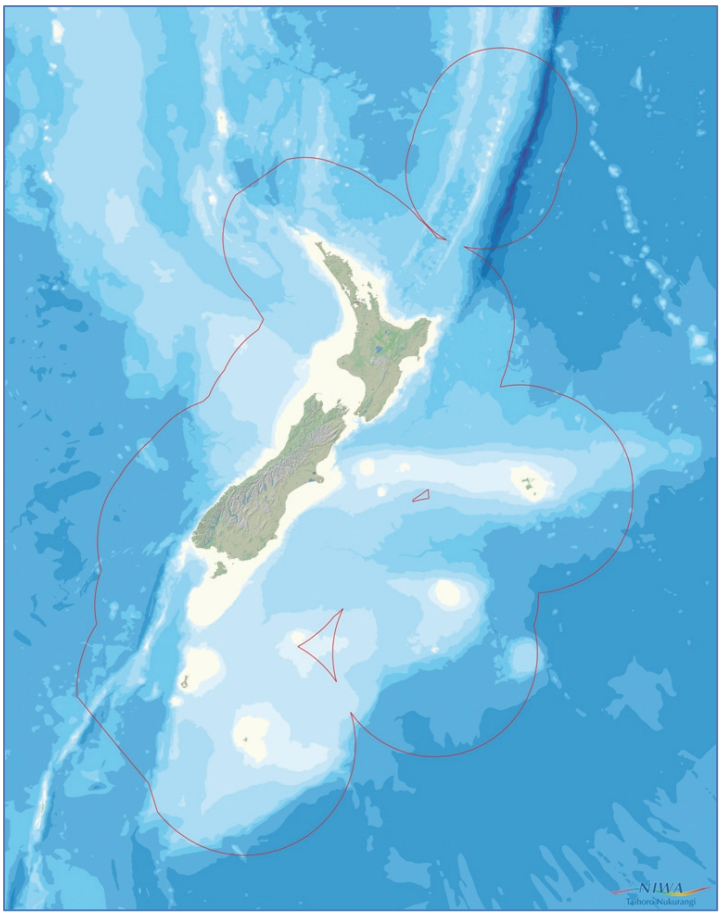
Chapter 6 concludes the report by integrating the material in chapters 4 and 5 to present a vision of what the agri-food sector in New Zealand might look like over the next ten years if it succeeds in maximising value creation through integrating domestic industry developments, science and technology innovation and trusted commercial brand creation in the new international trading environment. This vision covers aspects to facilitate the sector's growth such as the importance of industry leadership, private-public partnerships, effective science and innovation systems, the development of a credible country-of-origin brand, responsive skills development ecosystems and cooperative investment to support value chain enhancements.

2. Where We Are Today

2.1 Introduction

Figure 2-1 presents a map of New Zealand's land mass and its exclusive economic zone established under the 1982 United Nations Convention on the Law of the Sea. The natural resources within these boundaries are the foundation of New Zealand's agri-food industries considered in this report. The purpose of this chapter is to provide a statistical profile of these industries in the context of New Zealand's wider economy.

Figure 2-1: New Zealand and its Exclusive Economic Zone

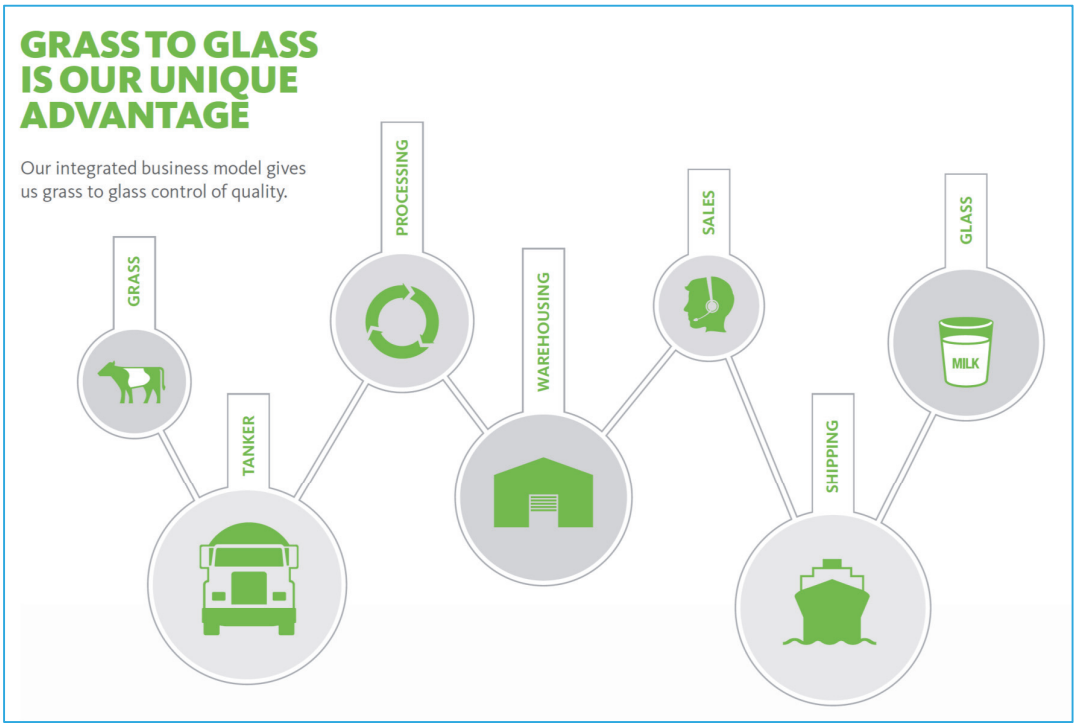


Source: NIWA, downloaded 13 April 2015 from https://www.niwa.co.nz/our-science/oceans/bathymetry.

One of the challenges in analysing the importance of the agri-food industries to the New Zealand economy is that there is a lengthy chain of value-adding steps in delivering the final product to the consumer. This is illustrated in Figure 2-2, taken from Fonterra's *Annual Report 2012*. Entitled "grass to glass", the value chain in the diagram illustrates how the production of milk on a dairy farm is only the beginning of the creation of value for the final consumer. Transport, processing, warehousing, sales (including marketing) and distribution all play their part. Further, this value chain is supported by other services such as accountancy, information and communications technology, research and development, contract law and public regulatory frameworks.

Consequently, it is a mistake to think of the agri-food sector as restricted to the producers in the economy's primary sector. There is no product without these primary producers, of course, but value is added in every step along the value chain, encompassing goods and services from all parts of the economy.

Figure 2-2: The Fonterra Value Chain



Source: Fonterra (2012, p. 8).

This chapter is predominantly based on statistical time-series data for at least a decade to the latest available year. This allows a picture to be painted of the present situation, but also allows recent trends to be depicted. The data are grouped under four headings: the contribution to gross domestic product (section 2.2); productivity and exports (section 2.3); social indicators (section 2.4); and environmental indicators (section 2.5).

2.2 Contribution to Gross Domestic Product

The key economic indicator for any industry is its 'value added'. This is the difference between the cost of the goods and services it purchases from other industries and the revenue from the goods and services it produces and sells itself. This difference is the 'value added' to the goods and services consumed as inputs into the industry. It measures the industry's contribution to gross domestic product (GDP) and also equals the income that is recorded by Statistics New Zealand in three categories: compensation of employees; gross operating surplus; and taxes net of subsidies on production.

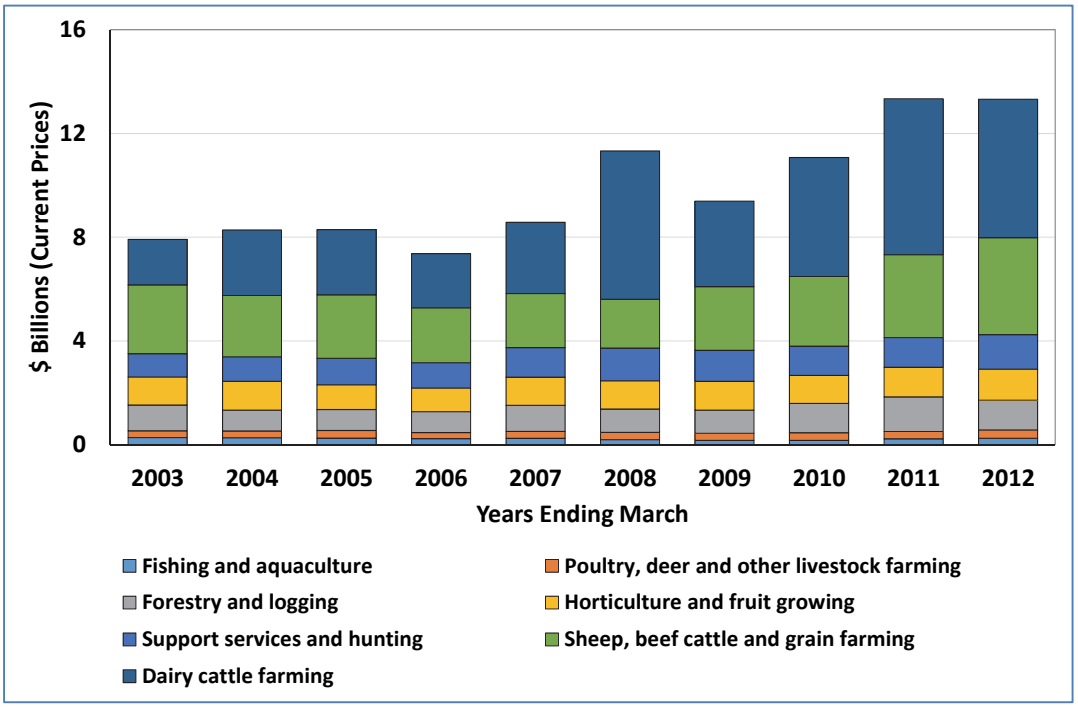
Statistics New Zealand has developed a framework for classifying the country's industries in order to highlight special features of the New Zealand economy. This framework, known as the New Zealand Standard Industry Output Categories (NZSIOC), defines 55 industries for which Statistics New Zealand publishes 'value added' data in the National Accounts (Industry Benchmarks) series. Of these NZSIOC industries, seven in the primary sector and eight in the processing sector are directly relevant to the agri-food sector. These fifteen industries are listed in Table 2-1.

Table 2-1: Agri-Food Primary Sector Industries and Processing Sector Industries

Primary Industries	Processing Industries
Horticulture and fruit growing	Meat and meat product manufacturing
Sheep, beef cattle and grain farming	Seafood processing
Dairy cattle farming	Dairy product manufacturing
Poultry, deer and other livestock farming	Fruit, oil, cereal and other food product manufacturing
Forestry and logging	Beverage and tobacco product manufacturing
Fishing and aquaculture	Textile, leather, clothing and footwear manufacturing
Agriculture, forestry and fishing support services and hunting	Wood product manufacturing
	Pulp, paper and converted paper product manufacturing

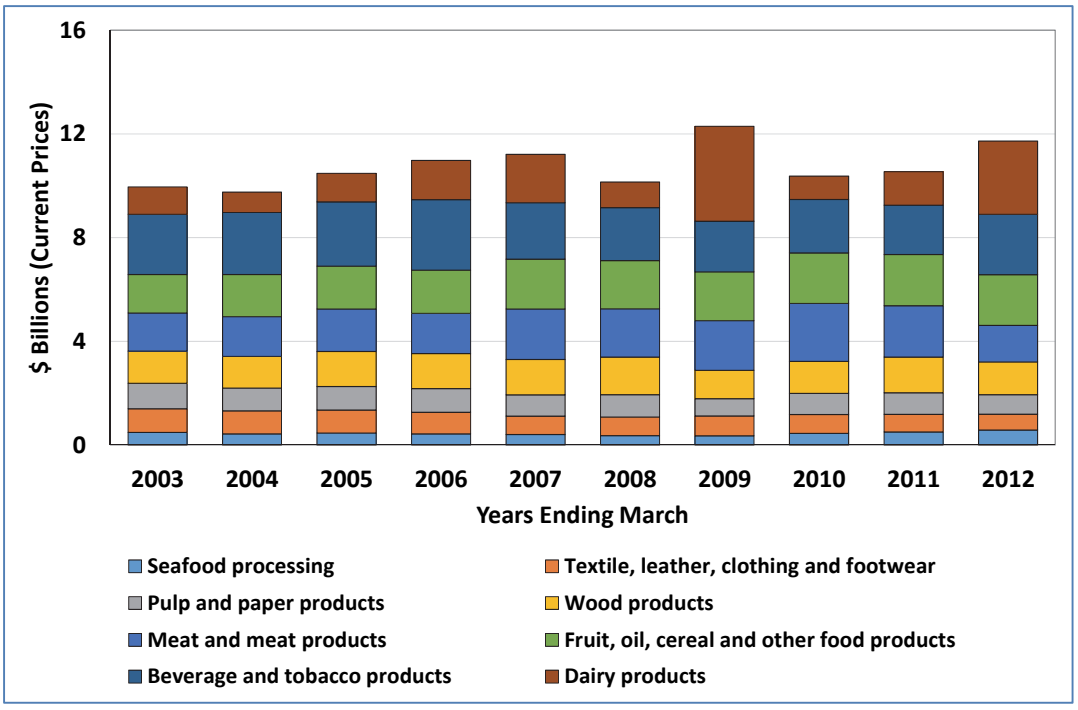
Figure 2-3 and Figure 2-4 present the value added by these industries between 2002/03 and 2011/12 (the latest published data at the time of writing this report). Figure 2-3 shows the primary industries and Figure 2-4 shows the processing industries. Note that no allowance is made in these figures for the small amount of inflation that occurs each year; nevertheless, the growth in the agri-food primary industries since 2005/06 is clear, especially in dairy cattle farming and in sheep, beef cattle and grain farming.

Figure 2-3: Value Added by the Agri-Food Primary Industries, 2002/03-2011/12



Source: Statistics New Zealand *National Accounts (Industry Benchmarks)*.

Figure 2-4: Value Added by the Agri-Food Processing Industries, 2002/03-2011/12



Source: Statistics New Zealand *National Accounts (Industry Benchmarks)*.

The fifteen industries considered so far are the core agri-food industries since all of their output is due to their position in agri-food value chains. Other industries are also important for those value chains, however, so that a broader definition of the agri-food sector should recognise these wider contributions.

To give an example, the Fonterra value chain in Figure 2-2 shows the key role of transport as tankers carry the raw milk solids from dairy farms to the processing factories. The value added by this service can be estimated using data from national input-output tables prepared from time to time by Statistics New Zealand. The most recent input-output tables are for the year ending March 2007 (Statistics New Zealand, 2012). One of the tables (Table 2-4) shows transactions made between industries. It records, for example, that in 2006/07 the dairy product manufacturing industry used services provided by the road transport industry valued at $294 million.

Further, the road transport industry also uses inputs provided by New Zealand industries. In 2006/07, for example, the road transport industry used services provided by the repair and maintenance industry worth $191 million and by the transport support services industry worth $152 million. Consequently, it is reasonable to say that the dairy product manufacturing industry (in this example) indirectly stimulated demand for outputs provided by the road transport industry, by the repair and maintenance industry, by the transport support services and so on.

Adding up these effects produces what input-output analysts term *indirect multipliers* or *Type I multipliers*. The researchers for this report used the Statistics New Zealand input-output tables to calculate indirect multipliers for the core agri-food sector, and these multipliers were then used to estimate the influence of the agri-food industries on the demand for the goods and services produced in each of the other industries throughout the national economy.

The results of these calculations are presented for the year ending March 2012 in Table 2-2. The first line shows that $254.7 million of the value added in the mining industry that year was to meet demand generated by the core agri-food sector. Another $837.9 million was generated in the petroleum, chemical, polymer and rubber product manufacturing industry (which includes fertiliser and pesticide manufacturing).

It is worth noting that the two largest industries in Figure 2-5 are financial and insurance services, and professional, scientific and technical services. These are examples of what are termed knowledge intensive business services (KIBS), widely considered important for a sector's competitiveness, growth and innovation (MBIE, 2014, p. 16).

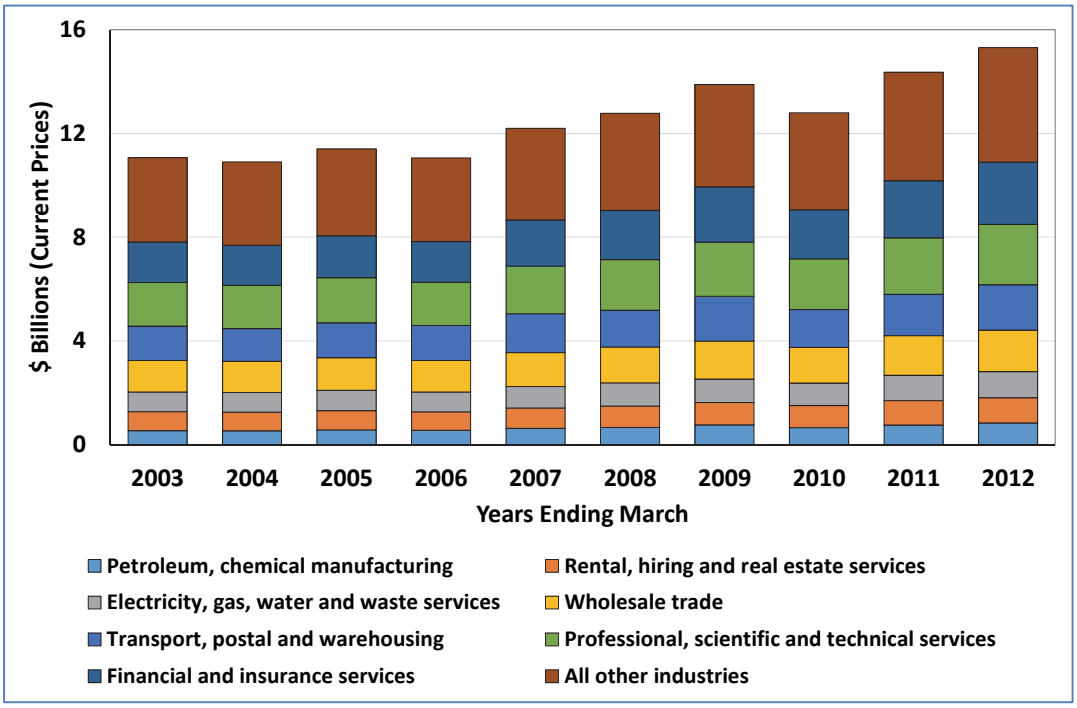
The multipliers used to calculate the values in Table 2-2 are for the year ending March 2007. In the absence of alternative data sources, it may be assumed that these multipliers can be used for other years around that date. Figure 2-5 therefore repeats the calculations of Table 2-2 for the years 2002/03 to 20011/12, showing the values for the top seven industries plus a residual for all other industries.

Table 2-2: Indirect Value Added from the Agri-Food Sector, 2011/12

Industries	$millions
Mining	254.7
Printing	143.3
Petroleum, chemical, polymer and rubber product manufacturing	837.9
Non-metallic mineral product manufacturing	82.6
Metal product manufacturing	426.5
Transport equipment, machinery and equipment manufacturing	294.6
Furniture and other manufacturing	30.2
Electricity, gas, water and waste services	1,011.8
Construction	394.8
Wholesale trade	1,598.7
Retail trade	424.1
Accommodation and food services	39.2
Transport, postal, and warehousing	1,747.3
Information media and telecommunications	724.4
Financial and insurance services	2,404.1
Rental, hiring, and real estate services	969.8
Owner-occupied property operation	0.0
Professional, scientific, and technical services	2,328.6
Administrative and support services	834.4
Local government administration	11.8
Central government administration, defence, and public safety	146.0
Education and training	110.5
Health care and social assistance	29.6
Arts and recreation services	23.0
Other services	444.6
TOTAL VALUE ADDED	**15,312.6**

Source: Authors' calculations, based on Statistics New Zealand (2012).

Figure 2-5: Indirect Value Added from the Agri-Food Sector, 2002/03-2011/12



Source: Authors' calculations, based on Statistics New Zealand (2012).

Another extension to the input-output analysis can be made. The direct and indirect incomes depicted in Figures 2-3, 2-4 and 2-5 have further flow-on effects because the receivers of those income purchase goods and services in their turn, stimulating further demand. Input-output analysts call this the "induced" effects and they are measured in the form of *induced multipliers* or *Type II multipliers*.

Care must be taken in interpreting the induced effects. It is legitimate to comment that induced effects are currently due to some particular industry (the dairy industry, for example), but this does not mean they are dependent on that industry. If the dairy industry reduced in size, there would be price adjustments (including perhaps a change in the New Zealand exchange rate) and other industries would expand to fill the gap.

For this section, however, the analysis is not trying to model the impact of changes in the agri-food sector, but simply to describe its importance to the national economy. Consequently, the induced multipliers need to be included in the study. Table 2-3 presents the 2011/12 induced value added currently resulting from the agri-food sector's activities, assuming that the induced multipliers for 2006/07 can be applied to the data for 2011/12. This adds another $12.9 billion to the reach of the agri-food sector into the wider New Zealand economy.

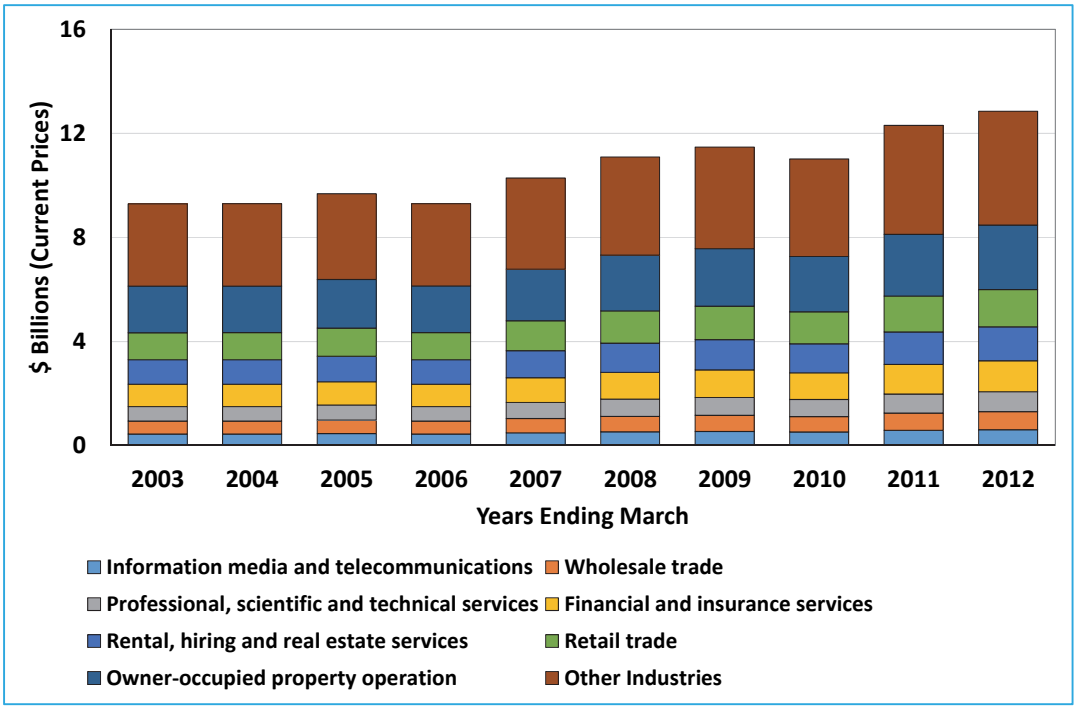
Table 2-3: Induced Value Added from the Agri-Food Sector, 2011/12

Industries	$millions
Mining	74.5
Printing	66.3
Petroleum, chemical, polymer and rubber product manufacturing	153.9
Non-metallic mineral product manufacturing	33.6
Metal product manufacturing	94.9
Transport equipment, machinery and equipment manufacturing	120.0
Furniture and other manufacturing	50.4
Electricity, gas, water and waste services	499.5
Construction	265.5
Wholesale trade	689.5
Retail trade	1,437.7
Accommodation and food services	492.7
Transport, postal, and warehousing	434.4
Information media and telecommunications	609.3
Financial and insurance services	1,186.4
Rental, hiring, and real estate services	1,302.9
Owner-occupied property operation	2,479.8
Professional, scientific, and technical services	770.9
Administrative and support services	282.6
Local government administration	10.8
Central government administration, defence, and public safety	100.1
Education and training	313.6
Health care and social assistance	556.9
Arts and recreation services	403.2
Other services	422.9
TOTAL VALUE ADDED	**12,852.4**

Source: Authors' calculations, based on Statistics New Zealand (2012).

Figure 2-6 presents the induced value added calculated using 2006/07 Type II multipliers for each year from 2002/03 to 2011/12. The figure highlights the seven largest induced impacts, the greatest of which is owner-occupied property operation.

Figure 2-6: Induced Value Added from the Agri-Food Sector, 2002/03-2011/12

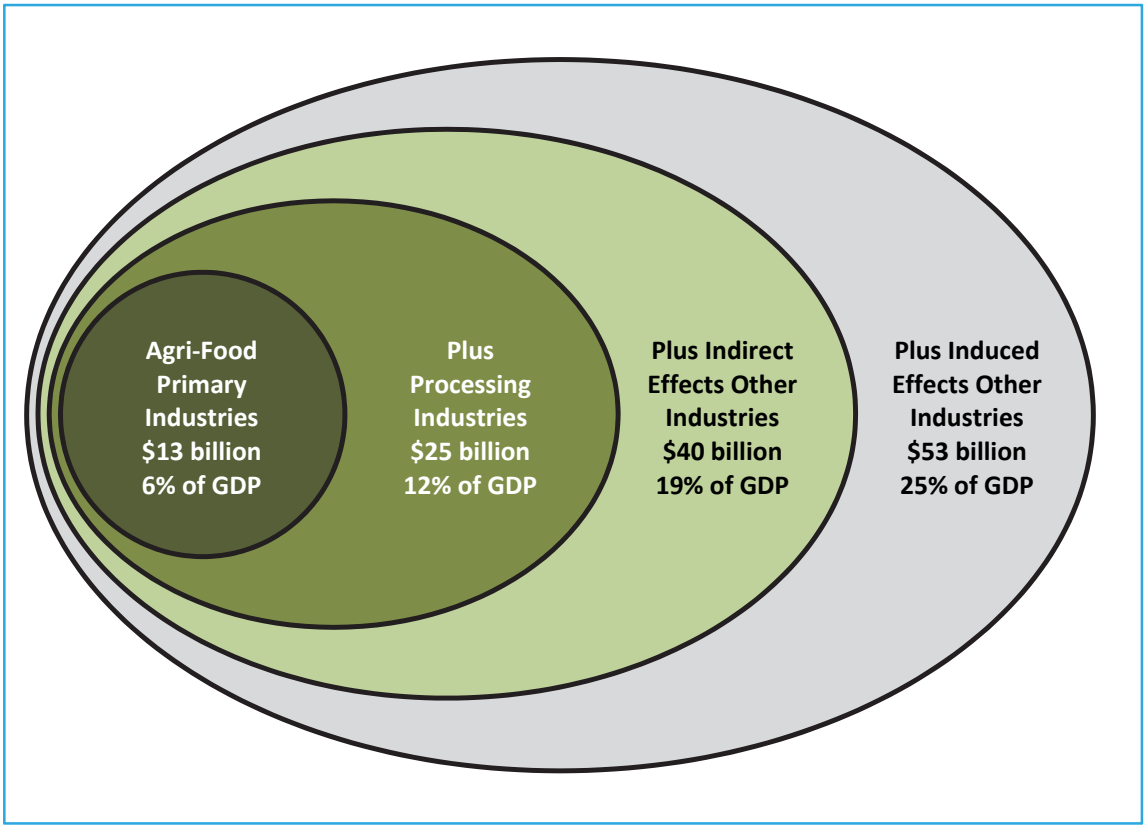


Source: Authors' calculations, based on Statistics New Zealand (2012).

It is possible to bring these estimates together into a single diagram showing how the importance of the agri-food sector for the national economy. This is done in Figure 2-7 for the year ending March 2012. It begins by adding up the value added by the agri-food primary industries, which Statistics New Zealand estimates was $13.3 billion, or 6 per cent of gross domestic product (GDP). It then includes the value added by the agri-food processing industries, which Statistics New Zealand estimates was $11.7 billion, increasing the contribution to $25.0 billion, or 12 per cent of GDP. The indirect effects of that activity on the value added of other industries are estimated by the AERU to have been $15.3 billion, which brings the total contribution to $410.4 billion, or 19 per cent of GDP. Finally, the induced effects currently produced by agri-food core industries are estimated by the AERU to be a further $12.9 billion, so that the total impact is $53.2 billion, or 25 per cent of GDP.

Figure 2-8 adds up the contributions to GDP in Figures 2-3, 2-4 and 2-5 and divides the result by total GDP for the years 2002/03 to 2011/12. The graph also shows the different components of this calculation.

Figure 2-7: Contributions of the Agri-Food Sector to Gross Domestic Product, 2011/12



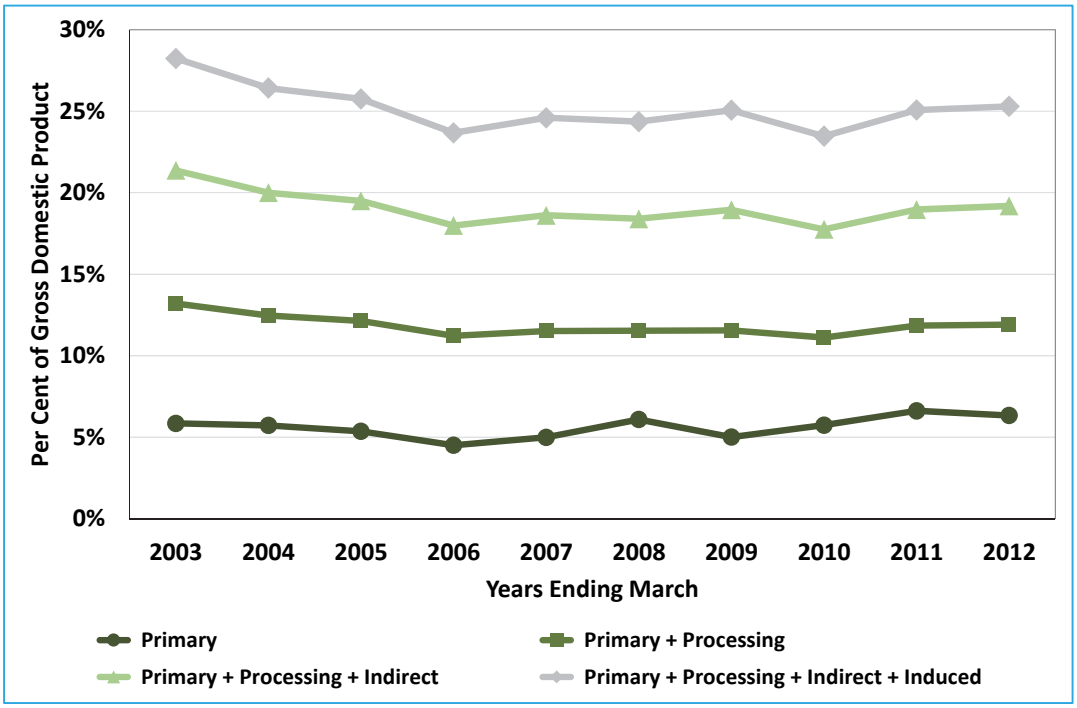
Source: Figure 2-3, Figure 2-4, Figure 2-5 and Figure 2-6.

The line closest to the horizontal axis shows the percentage of gross domestic product that is generated in the primary agri-food sectors. This was 5.7 per cent on average over the whole decade, although with some variation. The next line adds the share of the processing industries, which contributed 6.1 per cent of the economy's value added over the decade. Thus the combined primary and processing agri-food industries are around 12 per cent of GDP. This represents a sizeable proportion of the national economy – just under one-eighth of value-added comes from the agri-food primary and processing industries.

The third line in Figure 2-8 includes the indirect multiplier effects on the other industries in the economy. This contributed 7 per cent to national value added, so that the size of the broadly defined agri-food industry in New Zealand is around 19 per cent of GDP at factor prices. This explains why the economic performance of the agri-food sector is so important in New Zealand. **For every $5 of value created in the economy each year, just under $1 is due directly or indirectly to the agri-food industries.**

The final line includes the induced effects of the expenditure of the people who receive the incomes generated directly and indirectly in the agri-food sector. This income would be replaced by other sources if the sector was to shrink; nevertheless it is possible to say that currently 25 per cent of GDP is due to the direct, indirect and induced effects of the country's agri-food industries.

Figure 2-8: Share of the Agri-Food Sector in GDP, 2002/03-2011/12



Source: Statistics New Zealand *National Accounts (Industry Benchmarks)*.

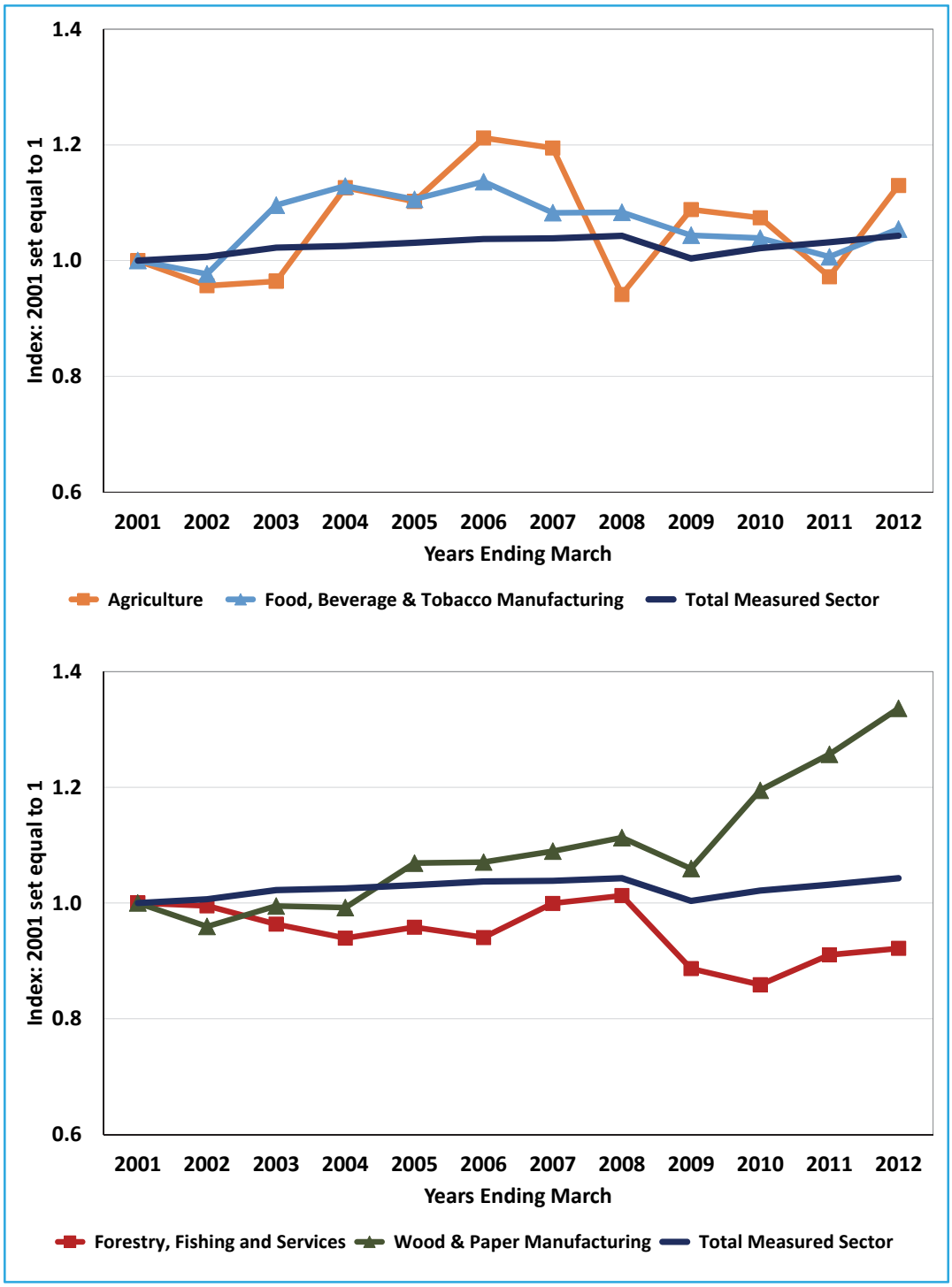
2.3 Productivity and Exports

Contribution to GDP is often taken as the principal measure of economic success, but other aspects of economic performance can be considered. Productivity growth, for example, is a driving force for economic prosperity. Productivity measures the value produced within an industry divided by the cost of its physical capital and labour. It is possible to measure capital productivity (value divided by the cost of physical capital), labour productivity (value divided by the cost of labour) and multifactor or total factor productivity (value divided by the cost of all factors of production). The last of these is argued to be the most accurate measure of productivity growth as it accounts for all relevant inputs (Ludena *et al*, 2007).

It is recognised that at least some parts of the agri-food sector have been important for New Zealand's productivity growth. A Treasury working paper published in 2006, for example, estimated that the multifactor productivity growth of the agriculture primary sector was 2.2 per cent per annum between 1956/57 and 1982/83, increasing to 2.6 per cent per annum from 1983/84 to 2000/01 (see Hall and Scobie, 2006, Figure 2, p. 5).

Statistics New Zealand publishes estimates of multifactor productivity for parts of the economy termed the measured sector (productivity in other parts such as public services are very hard to measure). The two graphs in Figure 2.9 show multifactor trends in four agri-food industries compared to the average for the measured sector (depicted as the solid line without markers). Both graphs present data for a primary industry and a processing industry.

Figure 2-9: Multifactor Productivity of Selected Industries, 2000/01-2011/12



Source: Statistics New Zealand *Infoshare*, Productivity Statistics - PRD: Productivity Indexes (ANZSIC06) and Productivity Indexes - Industry Level (ANZSIC06).

The top graph compares the productivity of agriculture with that of food, beverage and tobacco product manufacturing. Over the full twelve-year period, both industries are close to the measured sector average, although both show lower productivity in 2011/12 compared to their peaks in 2005/06. The bottom graph compares the productivity trends in 'Forestry, Fishing, and Services to Agriculture, Forestry and Fishing' and in 'Wood and Paper Product Manufacturing'. The former ends with lower productivity than in 2000/01, while the latter shows spectacular productivity growth in the last three years of the series.

Expenditure on research and development (R&D) is often associated with productivity growth (see, for example, Falloon, 2012). Statistics New Zealand surveys research and development activity in New Zealand; Table 2-4 presents data from its most recent report (Statistics New Zealand, 2013).

Table 2-4: Research and Development Expenditure by Socio-economic Objective, 2010 and 2012

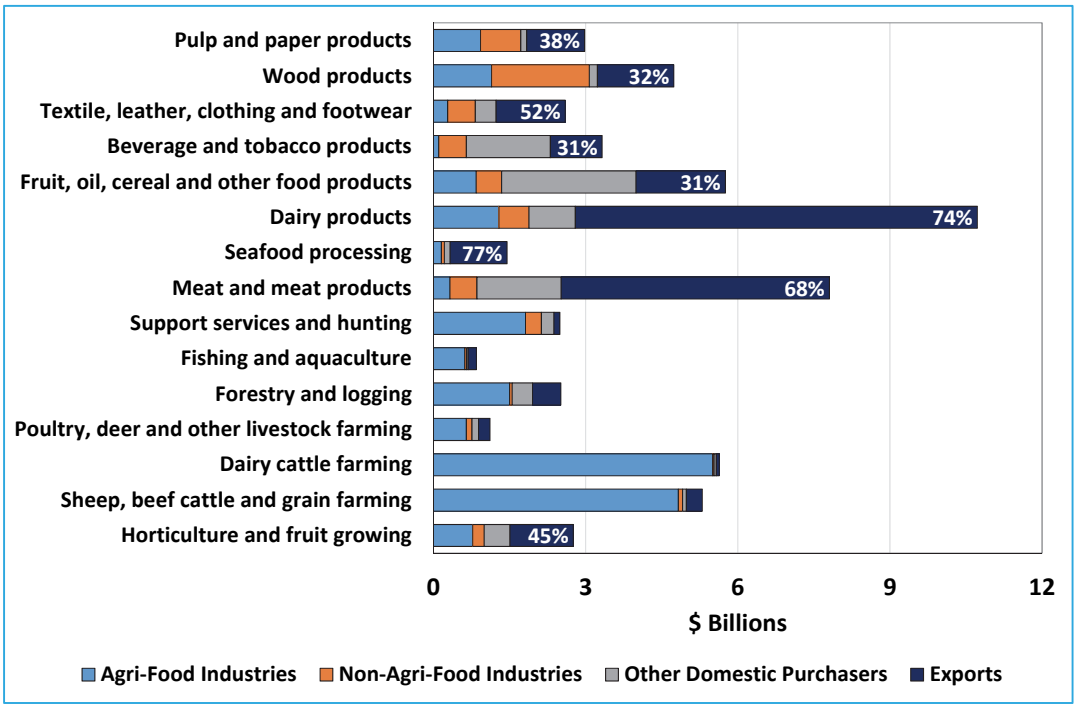
Socio-economic Objective	2010 ($m)	2012 ($m)	Per Cent Change
Primary Industries	389	457	17%
Energy	95	113	19%
Manufacturing	449	530	18%
Construction and transport	124	129	4%
Information and communication services	225	244	8%
Commercial services and tourism	46	69	50%
Health	313	317	1%
Education and training	102	114	12%
Law, politics and community services	41	55	34%
Cultural understanding	77	87	13%
Economic framework	54	39	-28%
Environment	283	264	-7%
Other (including defence)	81	99	22%
Knowledge – general (by universities)	109	107	-2%
TOTAL	**2,338**	**2,625**	**12%**

Source: Statistics New Zealand (2013, Table 7.01, p. 20).

The table records five socio-economic purposes where R&D expenditure is greater than $200 million per annum: manufacturing; primary industries; health; environment; and information and communication services. The increase in spending between 2010 and 2012 was 17 per cent, which was greater than the increase across all purposes (12 per cent).

Chapter 1 has already made the point about the importance of the agri-food sector for New Zealand's exports (see Figure 1-1). The corollary of that observation is that exports are important for the agri-food sector. This is illustrated in Figure 2-10, which uses the latest input-output tables provided by Statistics New Zealand (2012) to allocate the sales by the agri-food industries in 2006/07 to four categories: sales within the agri-food sector; sales to industries outside the agri-food sector; sales to other domestic purchasers (for final consumption or for investment in capital formation); and export sales to overseas purchasers of agri-food goods produced in New Zealand.

Figure 2-10: Source of Sales Revenue of the Agri-Food Industries, 2006/07



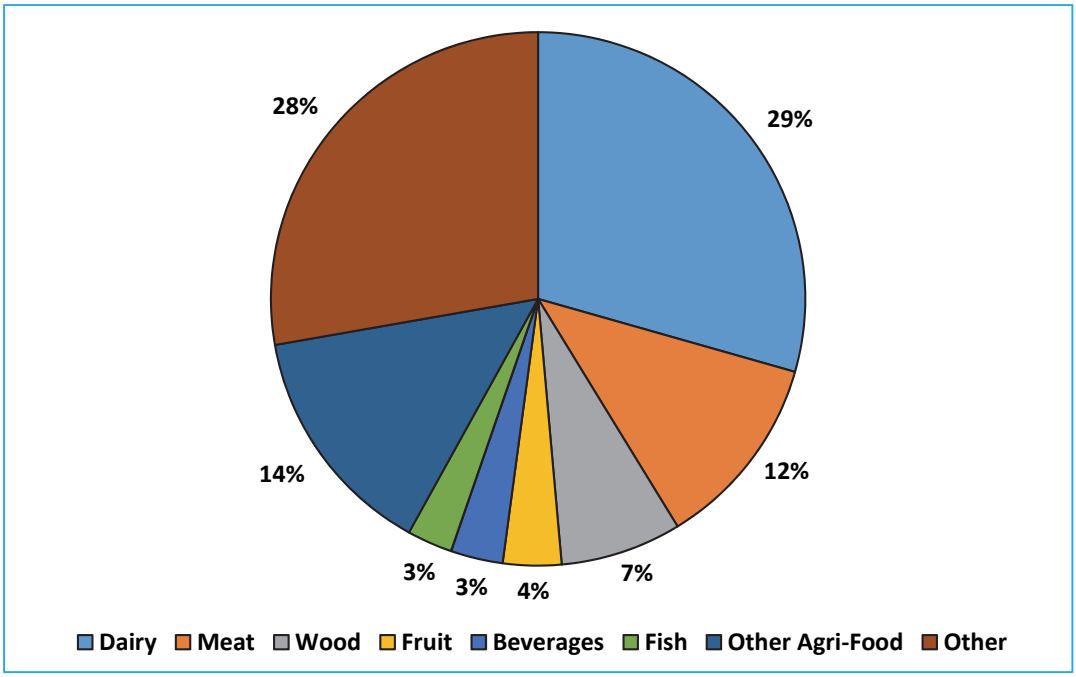
Source: Statistics New Zealand (2012).

The bottom seven industries in Figure 2-10 are the primary producers. Almost all of their sales are within the agri-food sector, since their outputs must be processed before sale to final consumers. The major exception is horticulture and fruit growing, where 45 per cent of the sales revenue comes from exports.

Among the processing industries, the reliance on exports is high. About one-third of sales revenue comes from exports in three of these industries. The proportion is one-half in textile, leather clothing and footwear manufacturing (52 per cent), two-thirds in meat and meat product manufacturing (68 per cent), and three quarters in dairy product manufacturing (74 per cent) and seafood processing (77 per cent).

Figure 2-11 and Table 2-5 show New Zealand's top six exports commodities, ranked by their total value in the calendar year 2014. Dairy products account for just under 30 per cent of total commodity exports, while dairy and meat products combined account for just over 40 per cent. The agri-food commodities shown in the table are nearly three-quarters of the value of total commodity exports (72 per cent).

Figure 2-11: Top Six New Zealand Exports by Total Value, 2014



Source: Statistics New Zealand *NZ.Stat*, Exports for Overseas Merchandise Trade (fob NZ$): Country of Destination by Commodity (HS2).

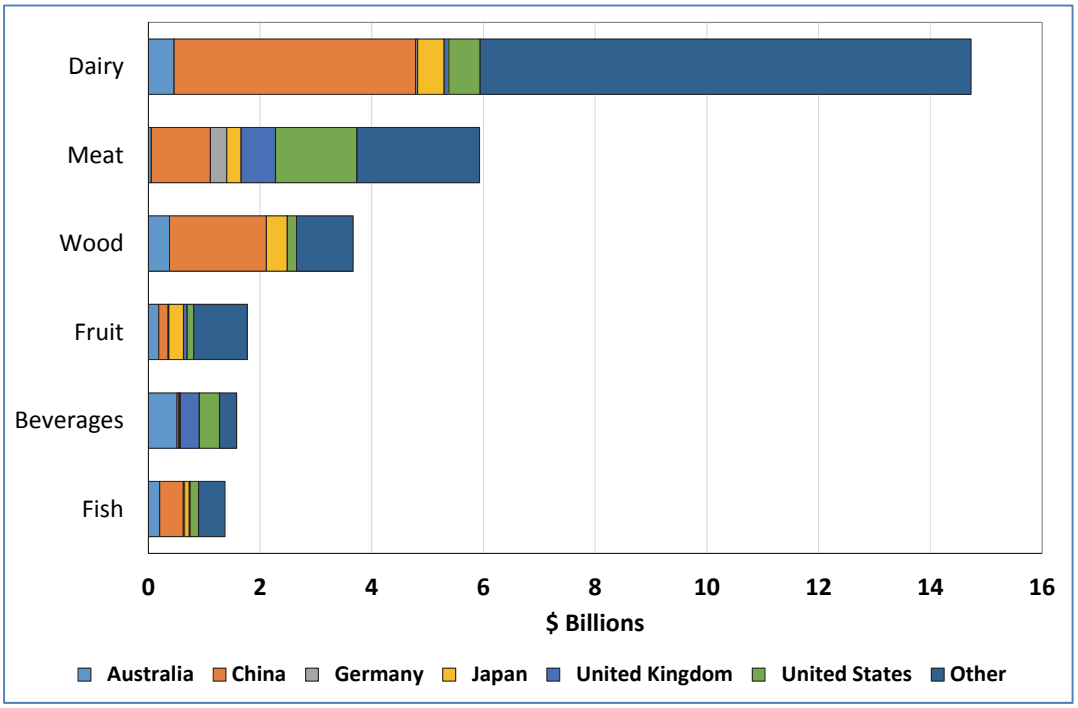
Figure 2-12 further analyses the top six exports by country of destination.

Table 2-5: Top Six New Zealand Exports by Total Value, 2014

HS Code	Commodity Category Name	Value ($ millions)	Per Cent of Total Exports
04	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere included	14,728.3	29.4%
02	Meat and edible meat offal	5,933.3	11.8%
44	Wood and articles of wood; wood charcoal	3,668.2	7.3%
08	Fruit and nuts, edible; peel of citrus fruit or melons	1,773.3	3.5%
22	Beverages, spirits and vinegar	1,581.2	3.2%
03	Fish and crustaceans, molluscs and other aquatic invertebrates	1,375.3	2.7%
	All other agri-food exports	7,114.8	14.2%
	All other exports	13,903.4	27.8%
	Total	**50,077.8**	**100%**

Source: As for Figure 2-11.

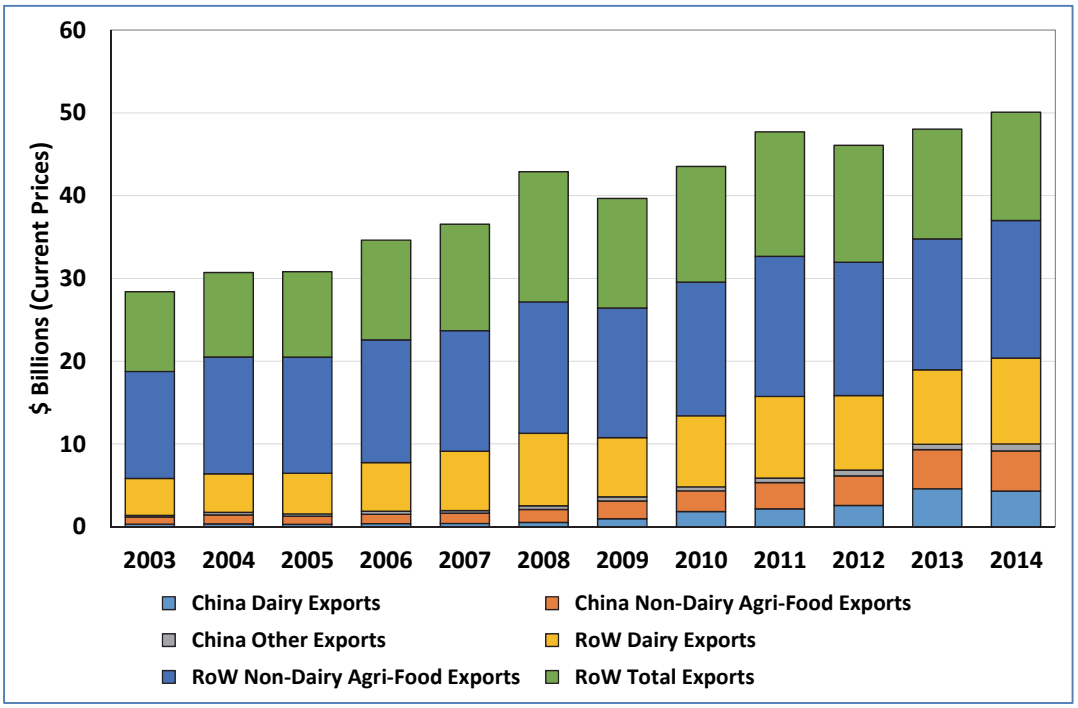
Figure 2-12: Major New Zealand Exports by Countries of Destination, 2014



Source: As for Figure 2-11.

Figure 2-13 shows New Zealand merchandise exports between 2003 and 2014. It reinforces the point made in the previous chapter that the share of agri-food exports in total exports has increased in recent years (see Figure 1-1). It also shows the importance of China for creating new export opportunities following the New Zealand-China Free Trade Agreement, which was signed on 7 April 2008 in Beijing, ratified through the New Zealand Parliamentary process in July 2008 and entered into force on 1 October 2008. Dairy exports to China, for example, increased from $521 million in 2008 to $4,326 million in 2014. Other agri-food exports to China also grew strongly over that period, from $1,572 million to $4,843 million.

Figure 2-13: New Zealand Merchandise Exports to China and Rest of World, 2003-2014



Note: RoW = Rest of World.
Source: As for Figure 2-11.

2.4 Social Indicators

Arguably the most important contribution made by the agri-food sector to social wellbeing in New Zealand is the employment and incomes it provides to large numbers of citizens. The New Zealand Census of Population and Dwellings provides information on the main industry employment of residents using similar categories as in section 2.2. Thus Table 2-6 presents the number of people in full-time or part-time employment in the *core agri-sector industries* recorded in the 2006 Census and the 2013 Census. This is a conservative estimate of agri-food employment, because it does not include employment created through the indirect and induced effects discussed in the previous section.

Table 2-6: Employment in the Core Agri-Sector Industries, 2006 and 2013

		2006	2013	Change
Agriculture	Full-time	84,669	81,285	-4.0%
	Part-time	23,913	24,294	1.6%
Aquaculture	Full-time	873	717	-17.9%
	Part-time	174	105	-39.7%
Forestry and logging	Full-time	4,884	4,797	-1.8%
	Part-time	684	672	-1.8%
Fishing, hunting and trapping	Full-time	1,749	1,731	-1.0%
	Part-time	357	432	21.0%
Support services	Full-time	15,078	12,615	-16.3%
	Part-time	3,045	2,766	-9.2%
Food products	Full-time	48,666	47,802	-1.8%
	Part-time	6,411	6,219	-3.0%
Beverage and tobacco products	Full-time	4,164	4,638	11.4%
	Part-time	702	816	16.2%
Textile, leather, clothing and footwear	Full-time	15,144	8,772	-42.1%
	Part-time	2,703	1,734	-35.8%
Wood products	Full-time	17,250	12,615	-26.9%
	Part-time	1,752	1,218	-30.5%
Pulp and paper products	Full-time	4,821	3,882	-19.5%
	Part-time	318	249	-21.7%
TOTALS	Full-time	197,298	178,854	-9.3%
	Part-time	40,059	38,505	-3.9%
	Total	237,357	217,359	-8.4%

Source: Statistics New Zealand *Census 2006* and *Census 2013*.

Table 2-6 shows that the number of people employed declined in most of the agri-food core industries between 2006 and 2013. The overall decline was 8.4 per cent, while the number of people in employment in all industries increased by 0.8 per cent. Thus the percentage of the employed labour force in the core agri-food industries reduced from 12.0 per cent recorded in the 2006 Census to 10.9 per cent recorded in the 2013 Census.

Box 2.1: Primary Producers Make Important Contributions to Urban Economies

Farm businesses can make an important contribution to the socio-economic wellbeing of urban communities through two expenditure paths: expenditure on inputs to farm businesses, and expenditure in inputs to the industries that process farm production into consumer items. In many regions of New Zealand, information on the nature and quantity of this contribution is crucial to understanding the flow-on effects of water resource management decisions that directly affect the primary sector to urban communities.

In 2012, the AERU was commissioned by Aqualinc Research Ltd to develop and test a method for quantifying the economic effects on specific urban areas of primary sector activities directly affected by water management policy decisions. The aim was to include these economic effects on Water Wheel diagrams alongside other economic and environmental indicators.

The researchers surveyed farms and rural businesses in the Selwyn and Waimakariri districts of Canterbury to estimate the percentage of expenditure on inputs to farm businesses that flowed into Christchurch City in order to assess how important the agricultural sector is to the city. Results showed that annually, $306 million of farm (including their households) expenditure and $511 million of secondary farm expenditure via rural businesses is directly spent in Christchurch – a total of $817 million.

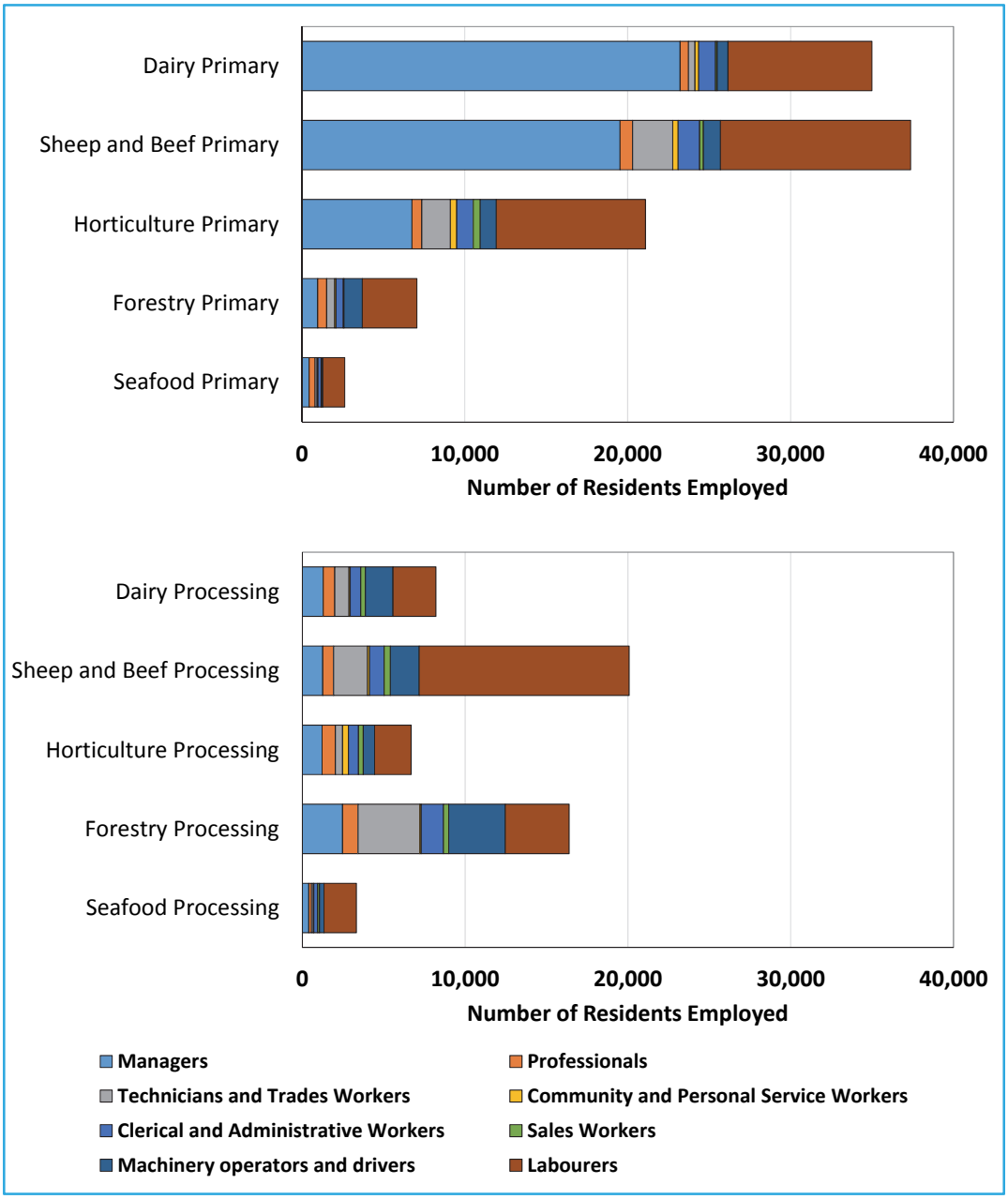
Sheep and beef farmers had the highest level of direct expenditure, spending more than $80 million per annum in the city; this was followed by expenditure from mixed cropping farmers, who spent more than $76 million in Christchurch. Dairy farmers annually spent $68 million in the city.

The flow-on effects of this expenditure, including the direct, indirect and induced effects of farms, and their secondary flows via purchases from rural businesses, were valued at $2.2 billion. This accounted for 10 per cent of Christchurch's total gross output and was associated with just over 12,500 full-time employees in the city.

The study results show that farm expenditure makes an important contribution to the Christchurch economy, and that economic activity in Christchurch City is connected to agricultural activity on the Canterbury Plains.

Figure 2-14 provides further analysis of the employment in the agri-food industries, presenting data on the level of occupations within each industry. This analysis is based on Census 2013 data requested from Statistics New Zealand, with user-defined industries based on the New Zealand Standard Industry Classification 2006 framework. Five primary industries and five processing industries were defined for this exercise as shown in the two graphs of Figure 2-14. Details of these definitions (based on 6-digit ANZSIC06 industries) are provided in Appendix 1 to this report.

Figure 2-14: Number of Residents Employed in Agri-Food Industries by Occupation, 2013

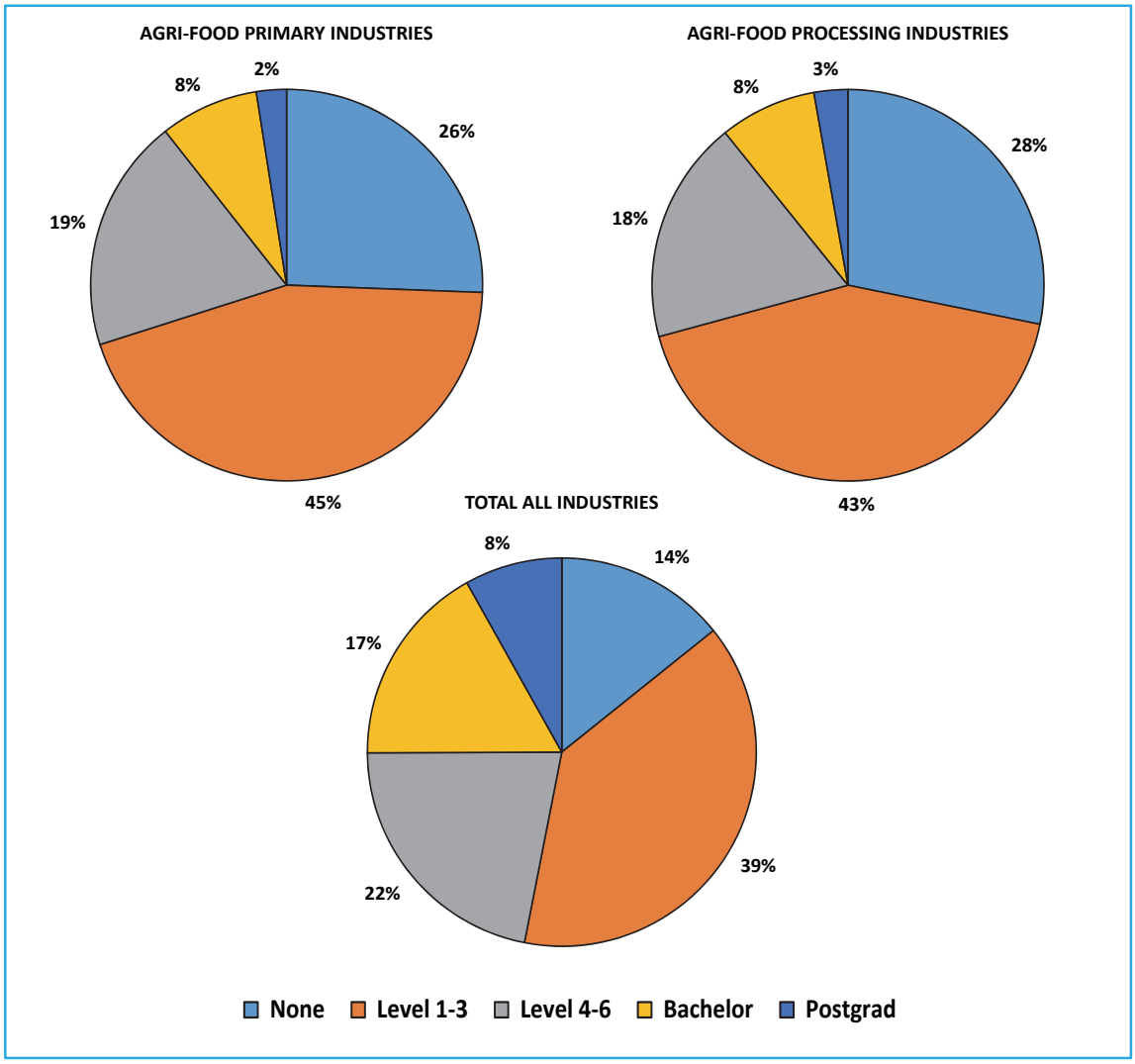


Source: Statistics New Zealand *Census 2013*.

The figure shows the large proportion of the primary sector workforce that is employed or self-employed as a manager. This reflects the importance of owner-operated farms and orchards in the New Zealand agri-food sector. The figure also shows the significant proportion of employment in the primary sector that is at the lowest skill level (that is, labourers). This is also a feature of the sheep and beef processing industry.

People working in the agri-food industries tend to have low level qualifications, both in the primary industries and in the processing industries. This is shown in Figure 2-15 and Table 2-7, which compare the distributions of qualifications in all industries with the agri-food primary industries and the agri-food processing industries, as reported in the 2013 Census. More than one-quarter of both workforces reported having no qualifications, while less than one-third reported qualifications beyond the equivalent of secondary school (Level 3).

Figure 2-15: Distribution of Qualifications in Agri-Food Industries, 2013



Note: These calculations exclude people whose qualification was not classified (or not stated).
Source: Statistics New Zealand *Census 2013*.

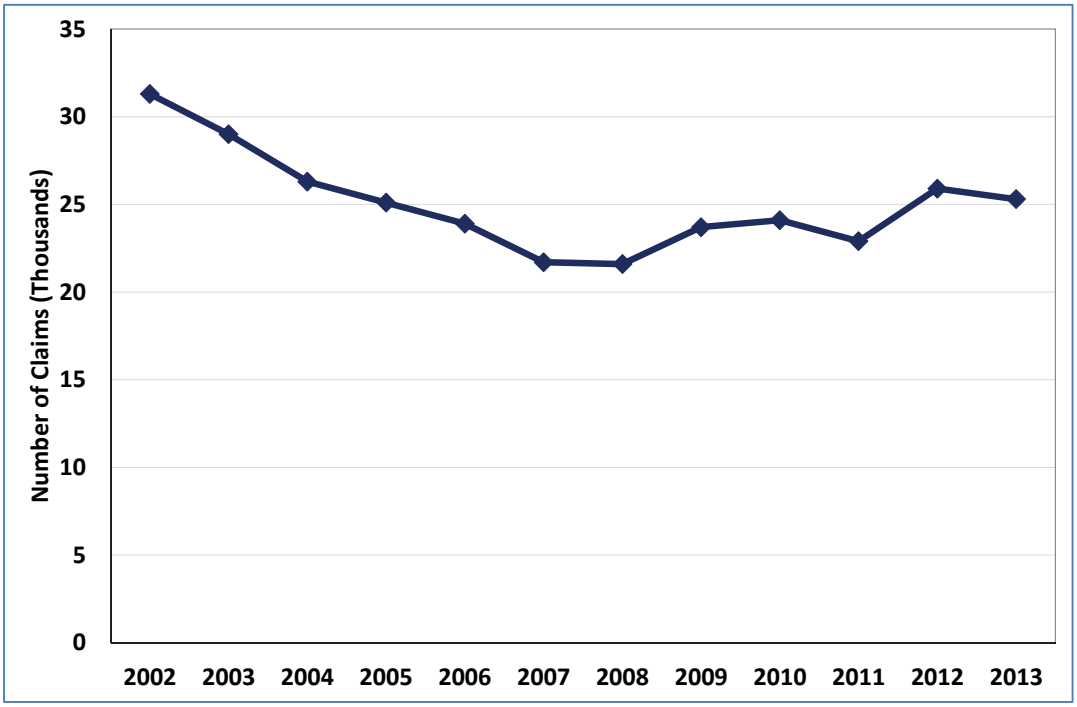
Table 2-7: Distribution of Qualifications in Agri-Food and All Industries, 2013

	Primary Industries		Processing Industries		Total All Industries	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
No qualification	31,692	25.6%	23,631	28.2%	273,615	14.2%
Level 1-3	55,083	44.5%	35,676	42.6%	746,598	38.8%
Level 4-6	23,883	19.3%	15,462	18.4%	420,123	21.9%
Bachelor Degree	10,077	8.1%	6,696	8.0%	325,497	16.9%
Postgraduate	3,069	2.5%	2,340	2.8%	156,114	8.1%
Not classified	5,619		4,149		79,059	

Source: Statistics New Zealand *Census 2013*.

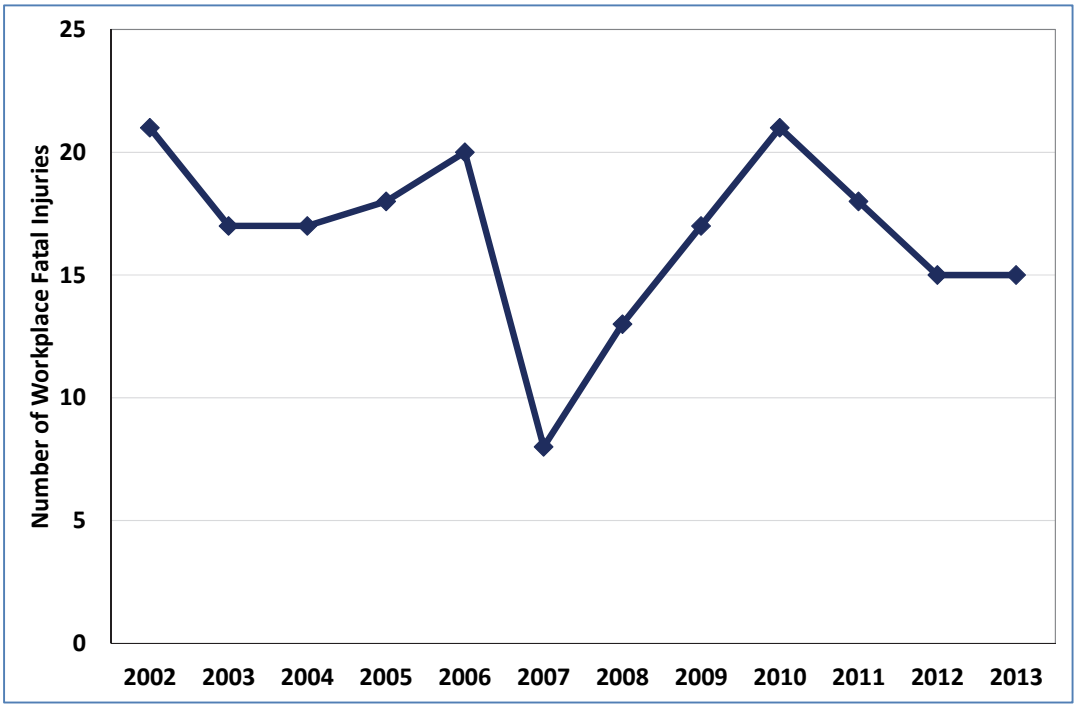
Workplace accidents have a negative impact on social wellbeing. WorkSafe New Zealand (2014, p. 8), for example, reports that almost half of the injuries between 2008 and 2013 in the New Zealand economy occurred in four sectors: forestry; agriculture; construction; and manufacturing. Figure 2-16 depicts the total number of claims between 2002 and 2013 for work-related injuries in agriculture, forestry and fishing primary industries, while Figure 2-17 depicts the total number of workplace fatal injuries in these industries.

Figure 2-16: Total Number of Claims for Work-Related Injuries in Agriculture, Forestry and Fishing Primary Industries, 2002-2013



Source: Statistics New Zealand *Injury Statistics – Work-related Claims*.

Figure 2-17: Total Number of Claims for Work-Related Fatal Injuries in Agriculture, Forestry and Fishing Industries, 2002-2013



Source: Statistics New Zealand *Injury Statistics – Work-related Claims*.

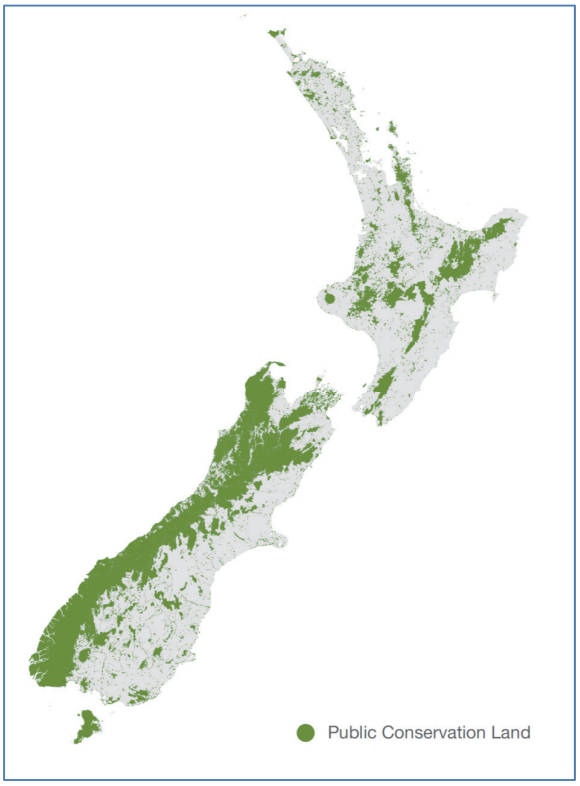
2.5 Environmental Indicators

Figure 2-1 at the beginning of this chapter presented a map of New Zealand's land mass and its exclusive economic zone. The agri-food sector depends on the natural environment for its prosperity and so participants are concerned about the ongoing health of that environment. Nevertheless, production can have harmful consequences that must be recognised and managed. The purpose of this chapter is to provide some statistical measures of the pressure that the natural environment experiences.

A feature of the New Zealand system of land management is that approximately 30 per cent of the country's land area is set aside under the management of the Department of Conservation (DOC). The total value of capital assets managed by DOC is $6 billion, of which $5.4 billion in Crown-owned public conservation land (Department of Conservation, 2014, pp. 82-83). Figure 2-18 is a map showing these conservation areas.

Table 2-8 draws on a resource by the Ministry for the Environment (2010) to provide a snap shot of land use in New Zealand in 2008 across 11 land use classes. This analysis is based on satellite imagery and aerial photographs to infer types of land use. It does not determine the intensity of different land uses.

Figure 2-18: Public Conservation Land Administered by DOC, 2014



Source: Department of Conservation (2014, p. 82).

From the table, about half of the land area in New Zealand is either low producing or high producing grassland, suitable for agricultural grazing land uses, such as sheep, beef or dairy farming. Natural forest covers about 30 per cent of the total land area, with another 10 per cent described to scrubland, 'other land', lakes and rivers, and wetland. Forest plantations account for up to 7 per cent of the land area. Cropping and horticulture use land is relatively small (around 2 per cent) and human settlements represent about one per cent.

Table 2-9 indicates how land use can change in response to market signals. It shows the number of livestock in New Zealand, drawing on Statistics New Zealand's *Agricultural Production Surveys*. Between 2002 and 2013, the number of beef cattle fell by 18 per cent, the number of sheep by 22 per cent and the number of deer by 38 per cent. At the same time, the number of dairy cattle increased by 26 per cent. This reflects improved profitability of dairying over other types of pastoral farming as a result of high world prices for dairy products, leading to strong growth in the national dairy herd (Saunders *et al*, 2011).

Changes such as these have environmental impacts. The Parliamentary Commissioner for the Environment (2013, p. 37), for example, has estimated that the conversion from a sheep and beef farm to a dairy farm on alluvial soil in Canterbury is likely to double the loss rate of nitrogen and increase the loss rate of phosphorus by about four times. In some catchment areas, nitrate and phosphate limits are significant constraints on further intensification of farming in their region.

Table 2-8: Land Use in New Zealand, 2008

Land use class	Description	Area in Hectares	Per Cent of Total Land
Cropping and horticulture	Annual crops or land cultivated for crops. Orchards and vineyards	422,400	2%
High producing grassland	Exotic grassland with highly productive vegetation	5,803,100	22%
Lakes and rivers	Open waters and riverbeds	529,600	2%
Low producing grassland	Exotic and indigenous grassland with lower productivity vegetation	7,705,800	29%
Natural forest	Forest and shrub that is not grazed around and is, or could grow to five or more meters tall	8,101,900	30%
New forest land	Natural or planted forest present in 2008 but not in 1990	586,600	2%
Forestry land planted before 1990	Exotic forest used for either timber production or protection; for example, erosion or river control. Includes harvested areas	1,432,400	5%
Scrubland	Scattered scrub within or near grassland not protected or managed for regeneration	1,059,600	4%
Settlements	Urban areas, towns and settlements	206,100	1%
Wetland	Wetland with vegetation	114,500	1%
Other land	Primarily bare of vegetation and not within settlements; for example, alpine gravel, snow and ice	889,100	3%
TOTALS		26,851,100	100%

Note: Land-use data is derived from the Land Use Carbon Analysis System (LUCAS) mapping. LUCAS mapping focuses on four key land-use classes, i.e., natural forest, forestry land planted before 1990, scrubland, and new forest land. All other land uses are determined from pre-existing datasets, such as the Land Cover Database (LCDB) versions 1 and 2 and the New Zealand Land Resource Inventory (NZLRI). Areas are rounded to the nearest 100 hectares.
Source: Ministry for the Environment (2010, p. 3).

Table 2-9: Number of Livestock in New Zealand, 2002-2013

Year	Dairy Cattle (000s)	Beef Cattle (000s)	Sheep (000s)	Deer (000s)
2002	5,162	4,491	39,572	1,648
2003	5,102	4,627	39,552	1,689
2004	5,152	4,447	39,271	1,757
2005	5,087	4,424	39,880	1,705
2006	5,170	4,439	40,082	1,587
2007	5,261	4,394	38,460	1,396
2008	5,578	4,137	34,088	1,223
2009	5,861	4,101	32,384	1,146
2010	5,915	3,949	32,563	1,123
2011	6,175	3,846	31,132	1,089
2012	6,446	3,734	31,263	1,061
2013	6,484	3,699	30,787	1,028

Source: Statistics New Zealand *Agricultural Production Surveys*.

The Ministry for the Environment maintains an environment reporting programme to monitor trends in New Zealand's environment (see the dedicated website at www.mfe.govt.nz/more/environmental-reporting/about-environmental-reporting-nz). The environmental reporting, including information on biodiversity and ecosystems, is organised under five domains: air; atmosphere and climate; fresh water; land; and marine. The national environmental indicators currently adopted in each of these five domains are presented in Table 2-10.

A relevant and representative example can be used to illustrate this environment reporting programme. The river condition indicator provides a national-level picture of the state of New Zealand rivers based on six water quality attributes: nitrates, total phosphorus, dissolved reactive phosphorus, bacteria (E.coli), ammonia, and aquatic insects (the macroinvertebrate community index, or MCI). The Ministry for the Environment notes that there is a lot of variability in New Zealand rivers with respect to the nutrient attributes, but "the median concentrations for nitrate, total phosphorus and ammonia in New Zealand rivers compare well to other OECD countries" (cited from Summary of nutrient results accessed 16 April 2015 at www.mfe.govt.nz/more/environmental-reporting/fresh-water/river-condition-indicator/nutrients).

Freshwater macroinvertebrates are small aquatic animals such as insects, worms, and snails. Their presence is affected by changes caused by human activity. The abundance of these is an indicator of overall stream health and water quality over time. The macroinvertebrate community index (MCI) provides a single number that summarises the pollution sensitivity of the macroinvertebrate community at a site. An MCI below 80 indicates poor water quality and an MCI greater than 119 indicates excellent water quality.

Table 2-10: National Environmental Indicators, 2014

Domain	National Environmental Indicators
Air	• On-road vehicle emissions • Annual average PM_{10} concentration • Health impacts due to exposure to human made PM_{10}
Atmosphere and Climate	• Emissions and removals of greenhouse gases • Levels of stratospheric ozone
Fresh Water	• River condition • Lake water quality • Groundwater quality • Suitability for swimming • Freshwater demand
Land	• Area of native land cover • Distribution of seven selected native species • Land cover • Land use • Soil health • Soil erosion risk
Marine	• Marine areas with legal protection • Fishing activity • Suitability for swimming

Source: Ministry for the Environment environmental reporting website, accessed 16 April 2015.

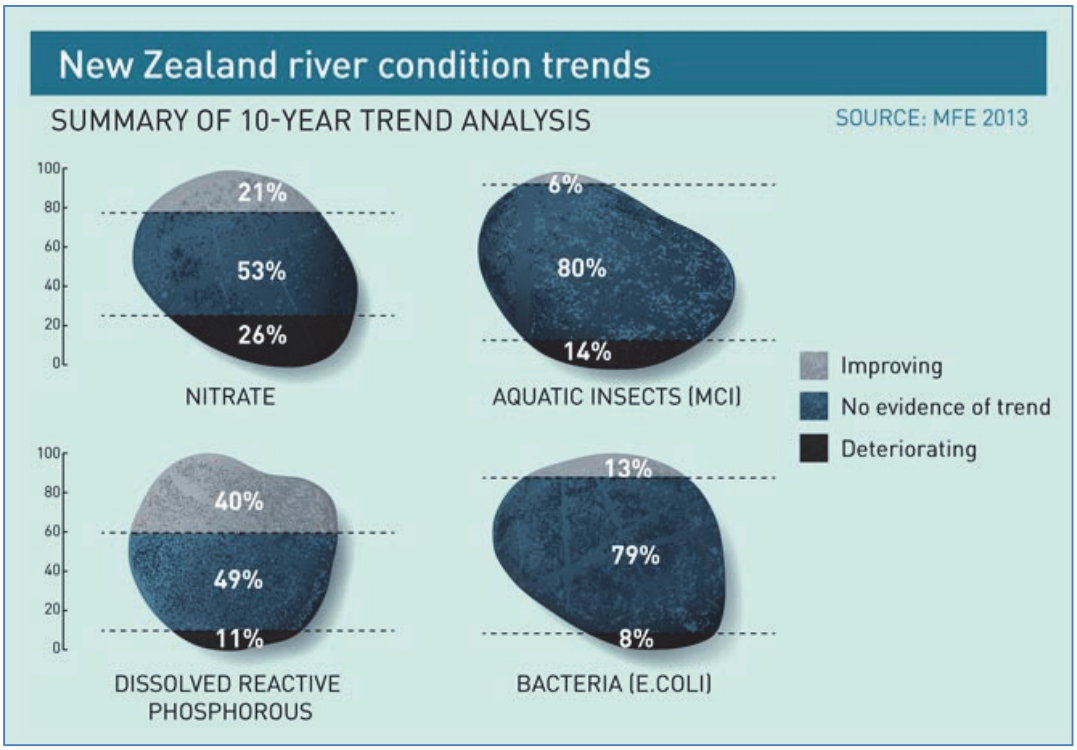
The Ministry for the Environment notes that with respect to macroinvertebrates, approximately half of streams in urban land catchments are estimated to be in poor condition (that is, they have an MCI score of less than 80) and that as a general observation streams in catchments affected by urban areas are significantly worse than in other land covers. It goes on to comment (downloaded from www.mfe.govt.nz/more/environmental-reporting/fresh-water/river-condition-indicator/macroinvertebrates, 16 April 2015):

> Rivers and streams in pasture catchments have the widest range of MCI score, with the range including the lowest in New Zealand to some of the highest. Such variability might reflect the wide range of environments, land-use intensities and management practices associated with pasture land cover. Improved land management practices, such as riparian planting, have a role in improving MCI scores.

The Ministry brings together aspects of river conditions into a single summary figure, which shows the percentage of monitoring sites where the river condition is improving, where it is deteriorating, and where there is no statistical evidence of a significant trend. The latest river condition indicator summary is reproduced in Figure 2-19. Nitrate levels are improving, for example, in 21 per cent of the river monitoring sites, but deteriorating in 26 per cent. This is an issue for the agri-food sector, since it is recognised that the most significant source of

nitrate at a national scale is animal urine. This has led to initiatives such as *The Dairying and Clean Streams Accord*, agreed in May 2003 by the Ministry of Agriculture and Forestry (now the Ministry for Primary Industries, the Ministry for the Environment, Fonterra and Local Government New Zealand (on behalf of regional councils).

Figure 2-19: River Condition Indicator Summary

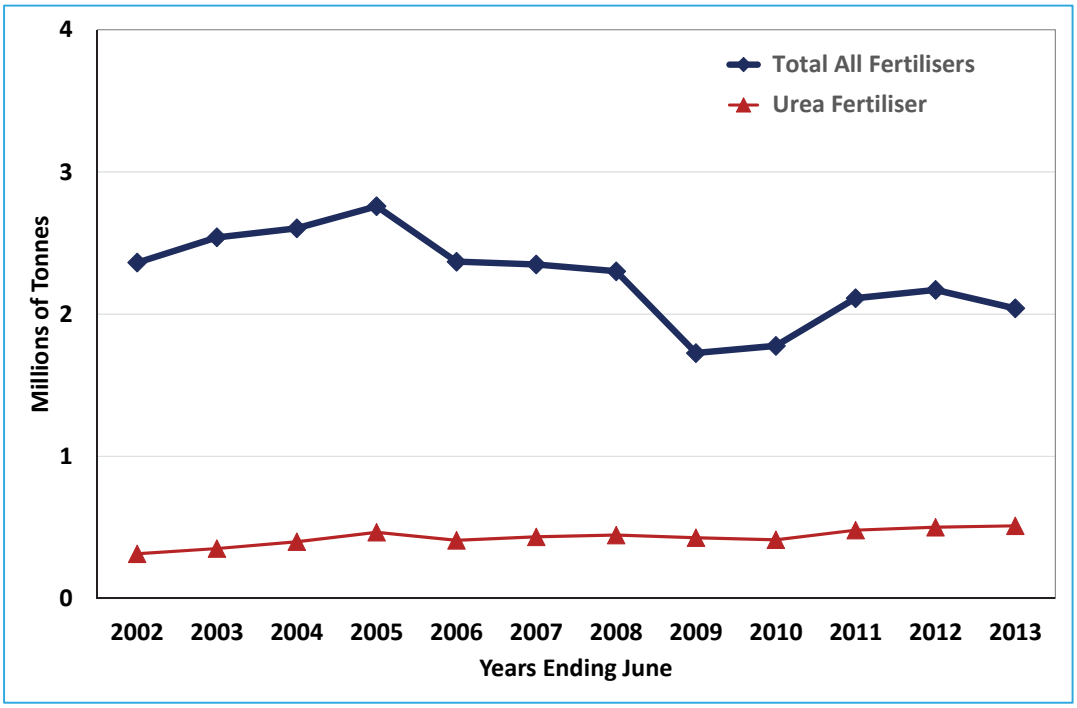


Note: These data are based on over 300 monitoring sites across the country.
Source: Ministry for the Environment environmental reporting website, accessed 16 April 2015.

Figure 2-20 plots the trend in fertilisers used in New Zealand between the years ending June of 2002 and 2013. Fertilisers commonly used in New Zealand include: lime; phosphatic (P) fertilisers; nitrogenous (N) fertilisers such as urea and ammonium sulphate; potassic (K) fertilisers; and compound fertilisers containing more than one nutrient, for example, di-ammonium phosphate (DAP) (Ministry for the Environment, 2007). During the period in Figure 2.20, the total use of fertiliser in New Zealand has dropped by 14 per cent. The nitrogen-based urea fertiliser, however, has increased by 63 per cent.

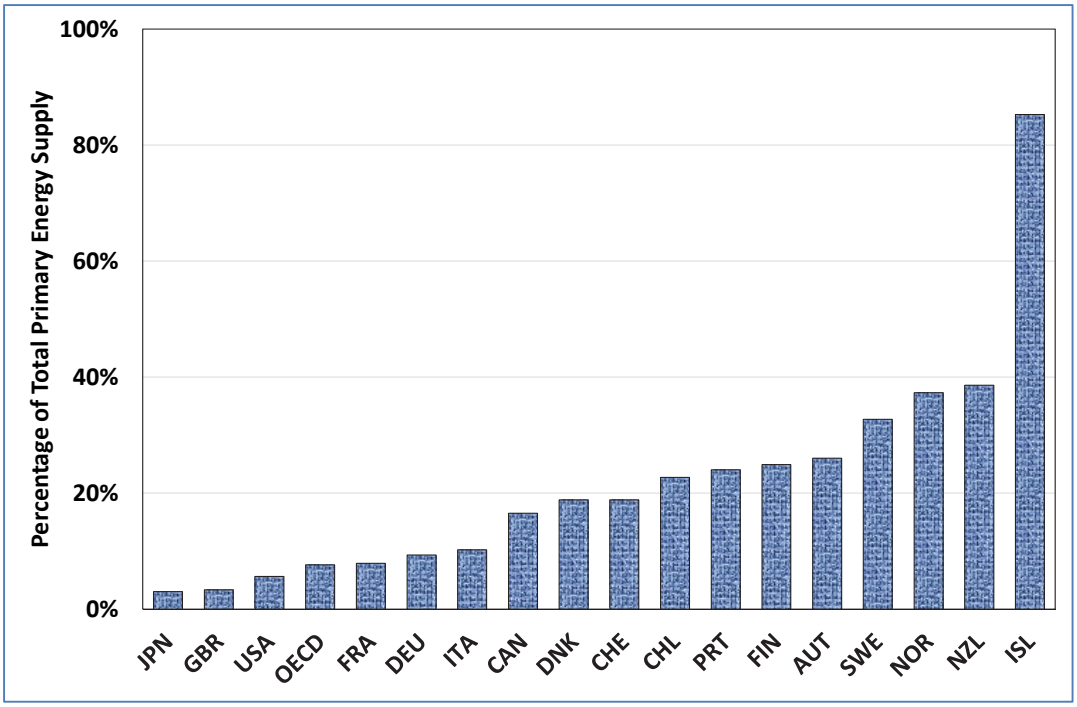
Finally, this report focuses on the agri-food sector, but land-based production involves other sectors such as energy generation. New Zealand has the second highest proportion in the OECD of its primary energy supply coming from renewable sources (see Figure 2-21). This demonstrates again the importance of New Zealand's natural environment for its economic wellbeing, but it has another implication for New Zealand agri-food producers because it means energy generation is a relatively low contributor of greenhouse gases – and agriculture is a relatively high contributor – compared to most other developed countries.

Figure 2-20: Total Urea and All Fertilisers, New Zealand, 2001/02-2012/13



Source: Statistics New Zealand *Infoshare*, Agriculture – AGR: Variable by Total New Zealand.

Figure 2-21: Contribution of Renewables to Energy Supply, OECD Countries, 2010



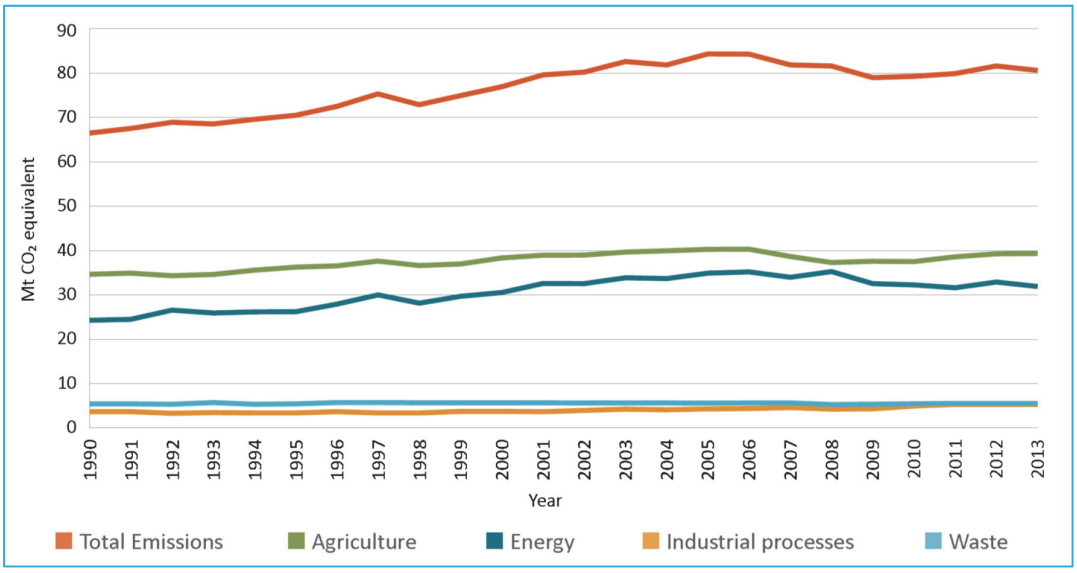
Source: OECD (2011).

This feature of the New Zealand economy is explained by the Ministry for the Environment (2015, p. 6) as follows:

> New Zealand's emissions profile is unusual among developed countries. For many developed countries, the agricultural sector constitutes only a small proportion of emissions, on average around 12 percent. Furthermore, CO_2 makes up about 80 percent of most developed countries' emissions. Due to the high level of agricultural production in New Zealand, most of it for export, our emissions profile is quite different. In New Zealand, methane and nitrous oxide (largely from agriculture) comprise over half of total national emissions (54.8 percent in 2013), while the remaining emissions consist largely of CO_2 (42.7 percent in 2013). New Zealand continues to improve the efficiency of its agricultural production, which resulted in a decreasing intensity of emissions from the agriculture sector.
>
> When considering atmospheric concentrations of greenhouse gases, CO_2 presents a long term challenge because it persists in the atmosphere for thousands of years. Methane and nitrous oxide have a strong warming effect, but do not persist in the atmosphere for a prolonged period of time. If New Zealand is compared with other countries on a CO_2-only basis, our emissions are 20th highest among Annex 1 countries and below the Annex 1 average, at 8.3 tonnes CO2 per person… A lower value of CO_2 emissions per person in New Zealand reflects the high proportion of our renewable energy generation.

Figure 2-22 shows trends in New Zealand's total greenhouse gas emissions from 1990 to 2013. It illustrates the Ministry for the Environment's observation that the contribution by the energy sector is relatively low, so that agriculture is the highest contributor in New Zealand, with an overall increase from the sector of about 14 per cent over the period.

Figure 2-22: New Zealand's total Greenhouse Gas Emissions, 1990-2013



Source: Ministry for the Environment (2015, p. 3).

The Ministry report cited above notes that the New Zealand agriculture sector is decreasing the intensity of its greenhouse gas emissions. Further, agri-food production in New Zealand involves lower emissions of the particularly damaging CO_2 because its farming systems are much less energy intensive than in many northern hemisphere countries, for at least three reasons:

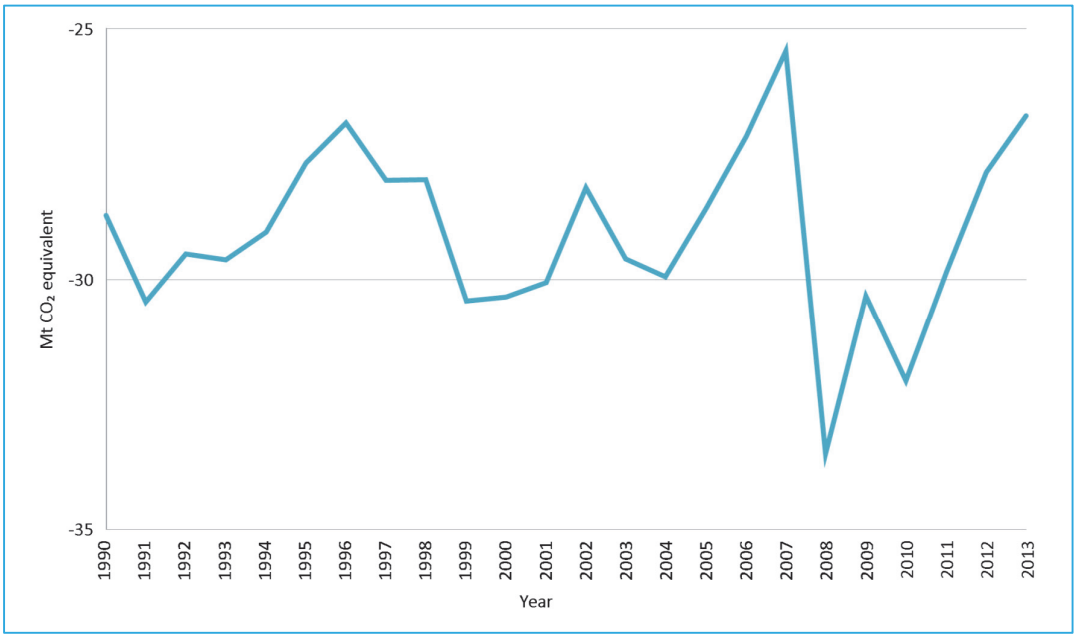
- Less fertiliser (which requires large amounts of energy to produce and cause significant CO_2 emissions) tends to be applied in New Zealand;
- New Zealand livestock can graze on grass year-round instead of requiring large quantities of brought-in feed such as concentrates; and
- New Zealand livestock do not require indoor housing (and heating) for extended periods of time as is the case for some farm systems in Europe and elsewhere.

This means that agricultural production in New Zealand can be much less damaging to the environment than in other countries, even taking into account the impact of transportation. This was demonstrated by Saunders *et al*. (2006) for four representative primary products in their contribution to the 'food miles' debate. The study's life cycle assessment derived the following conclusions at that time (idem, p. viii-ix):

> **Comparison of energy used and CO_2 emissions between NZ and UK Dairy**. The UK uses twice as much energy per tonne of milk solids produced than NZ, even including the energy associated with transport from NZ to the UK. This reflects the less intensive production system in NZ than the UK, with lower inputs including energy.
>
> **Comparison of energy used and CO_2 emissions between NZ and UK Lamb**. The energy used in producing lamb in the UK is four times higher than the energy used by NZ lamb producers, even after including the energy used in transporting NZ lamb to the UK. Thus, NZ CO_2 emissions are also considerably lower than those in the UK.
>
> **Comparison of energy used and CO_2 emissions between NZ and UK Apples**. NZ is also more energy efficient in producing and delivering apples to the UK market than the UK is. NZ energy costs for production are a third of those in the UK. Even when transport is added NZ energy costs are approximately 60 per cent of those in the UK. Consequentially the CO_2 emissions per tonne of apples produced are also higher in the UK than in NZ, reflecting the higher energy use but also the lower emissions from NZ electricity generation.
>
> **Comparison of energy used and CO_2 emissions between NZ and UK Onions**. The energy associated with onion production is higher in NZ compared with the UK. However, when storage is included for the UK, so they can supply the same market window as NZ can, the UK energy costs rise to 30 per cent higher than those in NZ, even accounting for transport.

Finally, forests act as a carbon sink, absorbing CO_2 from the atmosphere as they grow, so that the forestry sector in New Zealand is important for removing CO_2. The Ministry for the Environment estimates the size of these net removals of CO_2, which depending on factors such as growth rates, tree harvesting and changes in land use, as depicted in Figure 2-23.

Figure 2-23: Net Removals of CO_2 from Forestry and Other Changes, 1990-2013



Note that the vertical axis has negative values, so that a rise in the graph implies a reduction in net removals. Between 2004 and 2008, for example, the area of forests decreased due to deforestation of planted forests before the introduction of the New Zealand Emissions Trading Scheme.
Source: Ministry for the Environment (2015, p. 3).

3. How We Got Here

3.1 Introduction

The previous chapter has demonstrated the importance of the agri-food sector to New Zealand's national economy and its citizens. The core industries in the primary and processing sectors are measured to be 12 per cent of gross domestic product (GDP). When the sector is defined more broadly to include flow-on effects through other industries, the share of GDP is increased towards 20 per cent; that is, the agri-food sector is responsible directly or indirectly for $1 of every $5 of value created in the national economy each year. Allowing for the induced spending flows currently associated with this activity, the share of GDP increases to 25 per cent. Further, the outputs of the sector have always comprised more than 60 per cent of the country's merchandise exports; in 2014 this ratio was 72 per cent. More than 200,000 New Zealand residents recorded in the 2013 Census that their primary occupation was in the core agri-food industries and of course a greater number of people owe their job to this sector once indirect and induced impacts are included. There are social and environmental challenges in agri-food production, which reflect – at least in part – the scale of the sector in New Zealand compared to other developed countries.

The purpose of this chapter is to analyse the historical factors that have produced the situation where New Zealand's merchandise exports are so heavily weighted towards agri-food products and the national economy is so strongly influenced by the agri-food primary and processing industries. The aim is not to provide a closely detailed history of the overall sector or any of its components; there are whole books devoted to different aspects of the histories of these industries. Rather, the intention is to stand back at a distance to trace out the big picture of how the sector developed through the interaction of four key elements:

- Changes in international trade;
- Developments in domestic industries and policies;
- Innovations in science and technology; and
- Creations of trusted commercial brands.

The chapter is organised around five key events:

1. The early human migrations from the 13th to the 19th century
2. The first shipment of refrigerated meat to the United Kingdom in 1882
3. The Ottawa Agreement, signed in 1932
4. The end of bulk purchase agreements with the United Kingdom in 1954
5. The beginning of New Zealand's decade of economic reforms in 1984

These events define five periods to the present day, discussed in the sections that follow.

3.2 The Early Human Migrations

The magisterial book *Tangata Whenua: An Illustrated History* by Atholl Anderson, Judith Binney and Aroha Harris (2014) surveys the available archaeological and radiocarbon dating to examine when Aotearoa New Zealand was first colonised by Māori voyagers (idem, p. 36):

> Putting all the evidence together, it is apparent that colonisation throughout South Polynesia began in the thirteenth century. Some voyaging may have reached New Zealand later, although there is no clear evidence of this.

An analysis of whakapapa (genealogy) comes to a similar conclusion (idem, pp. 65-66):

> Given the various biases and sources of error in the data, the precise figures mean little, but they might be taken to suggest that, on the evidence of whakapapa, migration to New Zealand either occurred in about the fourteenth century or began about the turn of the thirteenth century, peaked in the fourteenth century and had essentially stopped by the early fifteenth century. In any event, the whakapapa fit well with the traditional proposition of a fairly narrow period of canoe migration.

These first colonists had to adapt to a country very different from their original homes in the Pacific, and they dramatically transformed their new environment: "Deforestation by burning, the consequential alteration of sedimentary regimes and landforms, the introduction of plants and animals, and the extinction or severe depletion of many native birds and reptiles constituted a massive acceleration in rates of environmental change" (idem, p. 72). Anderson proposes three phases of adaption with some overlap (idem, p. 73):

- Colonisation phase (1200-1400)
- Transitional phase (1300-1600)
- Traditional phase (1500-1800)

Archaeological evidence shows that horticulture was established during the colonisation phase, including the cultivation of sweet potato (kūmera), taro, gourd (hue), yam (uwhi), paper mulberry and probably tropical tī-pore. In the transitional phase, population growth was accompanied by extensive deforestation and the extinction of 32 land and freshwater species of birds, including the moa. Horticulture continued to expand rapidly. The traditional phase saw the construction of monumental earthworks known as pā. Anderson notes that 6,900 pā have been recorded "constructed in most districts at much the same time, starting about AD 1500" (idem, p. 92). These pā were associated with agriculture, requiring food to be stored for the resident population and also acting as a defensive deterrent to raids on agricultural lands or stores.

The first European contact occurred when two vessels under the command of Abel Tasman anchored in Golden Bay in December 1642. James Cook arrived in Poverty Bay in October 1769 and Jean-François-Marie De Surville arrived at Doubtless Bay in December that same year. These visits were the beginning of greater interaction between Māori and Europeans (especially sealers, traders and whalers, and then missionaries), with permanent European settlement beginning at the Bay of Islands in 1814 (idem, p. 159). Samuel Marsden is credited with introducing Shorthorn dairy cows that year and planting New Zealand first vineyard and fruit trees in 1819 (Stringleman and Scrimgeour, 2015; Palmer, 2012).

There was considerable trade between Māori and Europeans, and some trade with the colony of New South Wales. There was a difficulty in the latter relationship, however, since the British East India Company held a trading monopoly with New South Wales which gave it the authority to impound *British* ships and cargoes. This was arguably New Zealand's first instance of an international trade access problem. The solution was to invite Māori chiefs from the north to select a flag that could be flown by all vessels made or registered in New Zealand so that they were clearly not British. The meeting to do this was convened at Waitangi on 20 March 1834 by the British Resident at New Zealand, James Busby, and the flag chosen (Orange, 2004, pp. 13-16; Anderson *et al*, 2014, pp. 209-10). That meeting set the pattern for two subsequent meetings at Waitangi that saw the Chiefs of the United Tribes of New Zealand proclaim the Declaration of the Independence of New Zealand on 28 October 1835 and to sign the Treaty of Waitangi with the British Crown on 6 February 1840. The first part of Article 2 spoke specifically of the land and its resources under Māori control (downloaded 20 April 2015 from www.nzhistory.net.nz/files/documents/treaty-kawharau-footnotes.pdf):

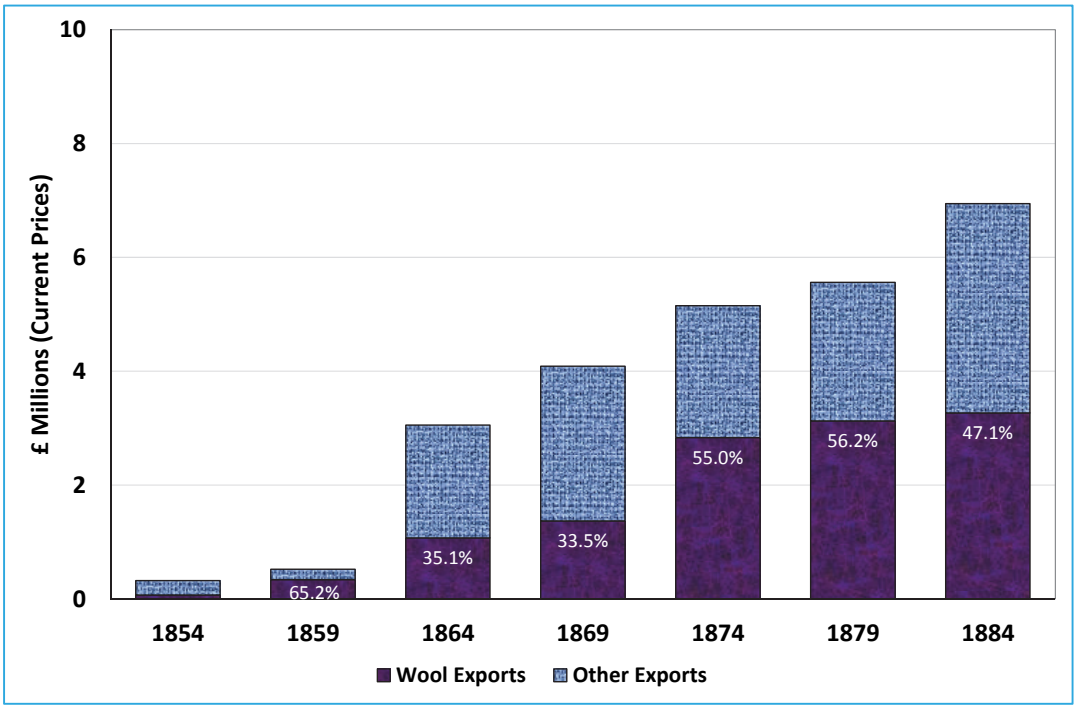
> **[English translation of the Māori text]** The Queen of England agrees to protect the chiefs, the subtribes and all the people of New Zealand in the unqualified exercise of their chieftainship over their lands, villages and all their treasures.
>
> **[English text]** Her Majesty the Queen of England confirms and guarantees to the Chiefs and Tribes of New Zealand and to the respective families and individuals thereof the full exclusive and undisturbed possession of their Lands and Estates Forests Fisheries and other properties which they may collectively or individually possess so long as it is their wish and desire to retain the same in their possession.

It is beyond the scope of this chapter to discuss the subsequent land wars and other ways in which this guarantee was not always honoured (see, for example, Belich, 1986), nor to discuss the work of The Waitangi Tribunal to address Māori grievances from this and later periods (see, for example, Hayward and Wheen, 2004).

Stringleman and Peden (2015) record that sheep farming began in earnest in New Zealand when Charles Bidwill, Charles Clifford, William Vavasour and Henry Petre transported 1,600 sheep from Australia in 1843. That same year, William and John Deans imported Merinos from Sydney to their Canterbury farm. In 1844 Johnny Jones ran 2,000 sheep on land leased from Māori in Otago.

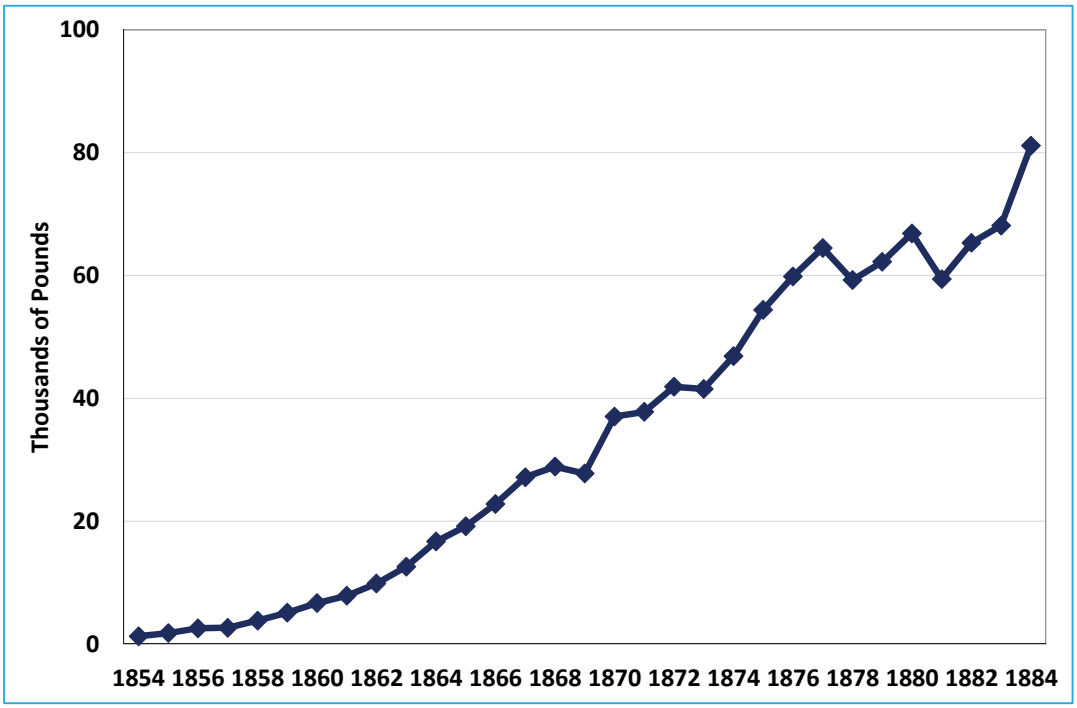
Wool became the first substantial export from New Zealand. Figure 3-1 shows five-yearly data for the value of New Zealand exports from 1854 to 1884 while Figure 3-2 shows the quantity of wool exported yearly over the same period. By 1874, wool was above 50 per cent of the value of all exports and was 56.2 per cent in 1879. As Hawke and Lattimore (1999, p. 6) explain, Argentina, Australia and New Zealand all had significant wool markets, but sheep meat could not be traded without chilling and refrigeration technology in transport. The first patents had been granted in 1831, but it was not until fifty years later that the first shipment of frozen meat was successful in 1882.

Figure 3-1: Value of Wool and Other Exports from New Zealand, 1854-1884



Source: *New Zealand Official Yearbook* 1893 and 1895, accessed 20 April 2015 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx.

Figure 3-2: Quantity of Wool Exported from New Zealand, 1854-1884



Source: *New Zealand Official Yearbook* 1893, accessed 20 April 2015 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx.

The growth in wool and other exports during the last three decades of the nineteenth century was facilitated by public investment in railways. The first railway opened in Christchurch in 1863 and a rail tunnel was constructed through the Port Hills to link the city to Lyttelton Port, completed in 1867 (Atkinson, 2012). The Southland provincial government completed a railway from Invercargill to Bluff in 1867. The big development in railways, however, began in 1870 when Julius Vogel (the Colonial Treasurer) announced that the government would borrow overseas to build a national network of railways. Atkinson (2012) records that by 1880 New Zealand Railways was operating over 1,900 kilometres of track, and carrying almost 3 million passengers and 830,000 tonnes of freight a year, mostly in the South Island.

Although wool exports were dominant, other developments in agriculture took place during these decades. A trial shipment of wheat flour to England in 1867 demonstrated that there was a market for New Zealand grain in Britain. In 1870, the first export of canned meat to the United Kingdom took place. The first dairy cooperative in New Zealand was formed by a group of farmers on the Otago Peninsula in 1871 and the first dairy factory opened at Edendale in 1881. A School of Agriculture was founded at Lincoln outside Christchurch in 1878, now Lincoln University, accepting its first students in July 1880. Its founding director, William Ivey, imported the first shipment of superphosphate in 1880, and local production began at the Kempthorne Prosser plant near Dunedin in 1882.[1]

As Figure 3-2 suggests, however, export growth stalled in the late 1870s and New Zealand entered into a period known as the long depression, which Easton (2009) suggests began with the collapse of the City Bank of Glasgow in 1878, which led to reduced credit available for New Zealand landowners at the same time as the world price of wool was falling. It was in this context that the introduction of refrigerated shipping in 1882 was timely to transform the New Zealand economy.

3.3 Refrigerated Shipping from 1882

On 15 February 1882, the *Dunedin* sailing ship left Port Chalmers carrying a frozen cargo of 4311 mutton carcases, 598 lamb carcasses and 22 pig carcasses, as well as an assortment of other items. The vast majority of the sheep meat came from the Totara Estate (near Oamaru) where a slaughtering shed had been built for the purpose. The voyage ended successfully 98 days later, although not without incident as recorded by Williscroft (2007, p. 14):

> At one stage in the tropics, the ship maintained one tack for a long time, which led to the cold air not being sufficiently well circulated among the carcasses. Determined that his cargo reach London in the best possible condition, Captain Whitson crawled into the main air duct to cut new opening to allow for the better escape of cold air. However, the improved circulation of chilled air made him so numb that he was soon unable to move and was in danger of freezing to death. Fortunately, the mate heard his cries for help and crawled in behind him. He attached a rope to this captain's feet and pulled him from his perilous position.

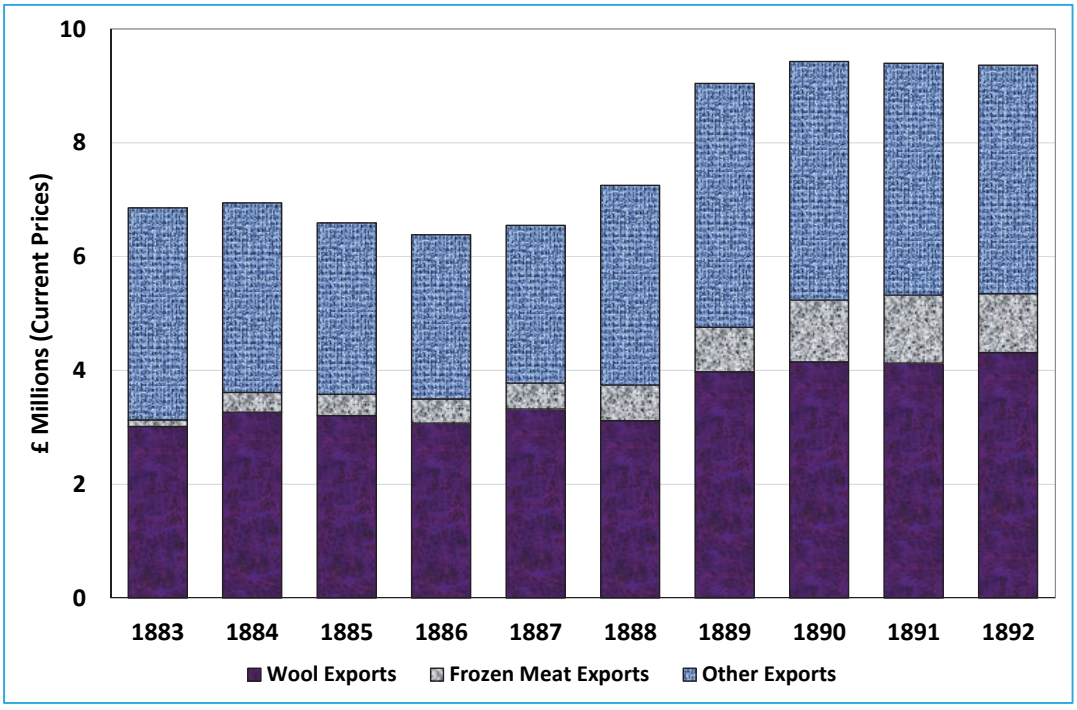
[1] The facts in this paragraph are taken from *Te Ara - The Encyclopedia of New Zealand*, including from the following entries: East (2013); Galbreath (2013); Roberts (2013); Stringleman and Scrimgeour (2015); and Zydenbos (2012).

The entire shipment was sold within a fortnight at twice its New Zealand price. The Land Company made a profit of more than £4,200, on top of a £500 bonus it received from the New Zealand government for the first 100 tons of refrigerated meat from New Zealand arriving in Europe in a saleable condition (idem, p. 15).

The first shipment of frozen meat was not a panacea for New Zealand's immediate economic problems. Figure 3-3 shows how the export of frozen meat expanded over the next decade, but was still a small share of exports in 1892 (comparable in value to the export of gold at the time). Nevertheless, the voyage of the *Dunedin* demonstrated that food – not just meat, but also dairy and other products – could be profitably sent from New Zealand to Europe. The United Kingdom's commitment to free trade made this an attractive proposition, which was to have profound implications for the New Zealand economy, as summarised by Greasley and Oxley (2009, p. 347; see also Hawke, 1985, chapter 5):

> What was more distinctive about New Zealand was the extent to which refrigeration-related staple exports promoted deep changes in economic organization and efficiency that heightened economy-wide productivity. … However, refrigeration did not guarantee economic transformation; rather, it made intensive growth possible. New Zealand's remarkably high income per capita depended on the responses to opportunities shaped by technological changes. Those responses led to higher land productivity and stimulated factory employment to process dairy and meat products, benefiting productivity further.

Figure 3-3: Value of Wool, Frozen Meat and Other Exports from New Zealand, 1882-1892



Source: *New Zealand Official Yearbook* 1893 and 1895, accessed 20 April 2015 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx.

The increase in meat and dairy exports to the United Kingdom towards the end of the 19th century led to the development of brands to distinguish New Zealand produce. Peden (2012), for example, observes that "in 1895 it was noted in newspapers that 'Canterbury' had become the standard term for the best class of meat exported from New Zealand, regardless of its actual place of origin". Hawke (1985, p. 85) similarly notes that efforts had to be made "preventing interlopers from using the band name of 'Canterbury'". It remains a valued marketing term to the present day (ANZCO, 2015):

> For over 100 years the Canterbury region of New Zealand, has been the source of some of the world's finest beef and lamb. Fertile plains, a temperate climate and generations of dedicated farmers make the region a natural food bowl.
>
> Canterbury Beef and Lamb today is a natural fulfilment of a promise, that begins on New Zealand's dew-covered pastures, of an exceptional and memorable eating experience. A reflection of all the bounty, quality, and heritage of this famous area of New Zealand.

Another brand that has stood the test of time is 'Anchor', which was created in 1886 by Henry Reynolds to label butter produced from his dairy factory at Pukekura in the Waikato (see www.cambridgemuseum.org.nz/Articles/pukedryfcty.htm). Fonterra currently describes Anchor as its flagship brand, which it uses to sell a wide range of dairy products in 70 countries (Fonterra, 2015):

> Anchor is an iconic brand, developed in New Zealand more than 125 years ago. With more than a century of dairying tradition behind us, we lead the way in developing top quality dairy products, tailored to suit the needs of people across the world. We take great pride in providing gold standard quality dairy products and that is why we are involved in every stage of the supply chain – from cow to consumer.

Research and technological developments played important roles in developing the sheep meat and dairy industries. In 1905, for example the New Zealand Sheep Breeders' Association officially sanctioned the Corriedale breed, which was New Zealand's first sheep breed. The name came from the first experiments in crossing Merinos with long-wool breeds by James Little, who managed Corriedale Station in North Otago; it is now farmed in North and South America, Australia and Eastern Europe, as well as New Zealand (Stringleman and Peden, 2015).

The possibility of refrigerated exports encouraged the development of small dairy farms focused on milk production, assisted by the Liberal government's (1890-1912) policy of dividing the great estates into smaller farms. There was a switch from the dual purpose Shorthorn breed to the Jersey breed (which produced more milk-fat) and the introduction of hand-operated centrifugal separators from about 1910 allowed milk to be separated on-farm (Hawke, 1985, pp. 88-90; Peden, 2012). The Dairy Industry Act 1894 provided for grading dairy products for export and set up inspectors of dairy factories (Stringleman and Scrimgeour, 2015). Nevertheless, development of this export industry was slow; it was only around 1920 that there were any dramatic increases in exports of butter and cheese (see Hawke, 1985, Figures 5-3 and 5-4, p. 91).

Other export industries began to develop. The first export of apples was from Christchurch to Chile, sent in 1888. The first consignment of frozen fish was exported to Sydney in 1890. Three species of salmon were introduced into New Zealand rivers from 1901. In 1904, Isabel Fraser

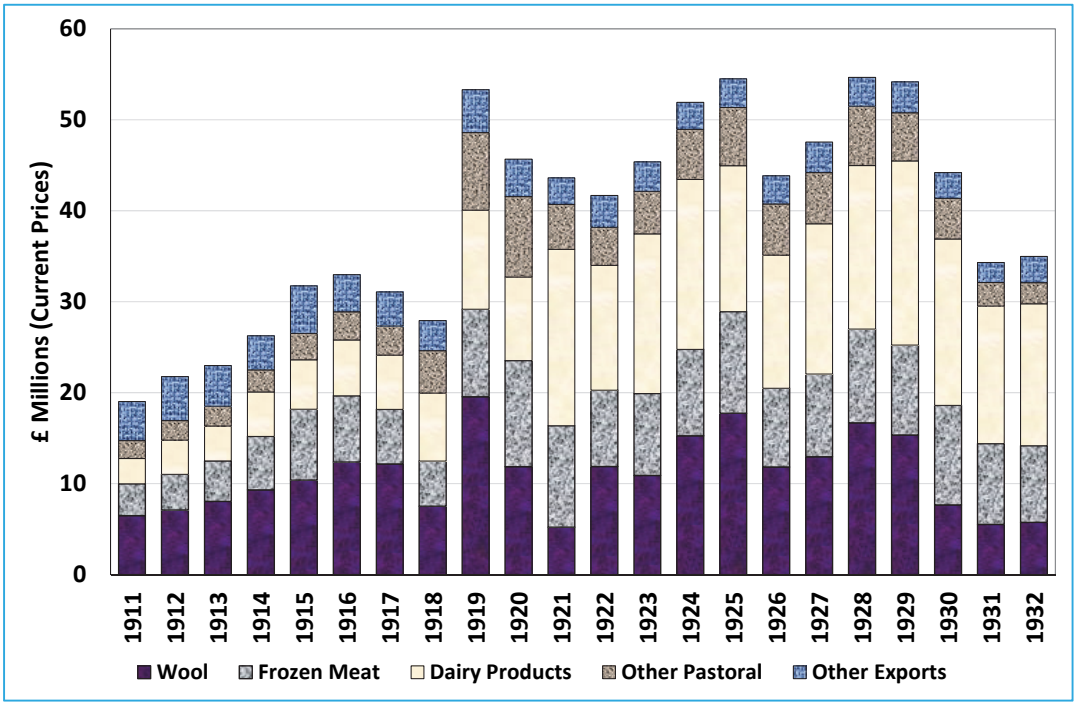
brought Chinese gooseberry seeds back from her time as a missionary in China; the seeds were sown by Alexander Allison in Whanganui in 1904. There were major programmes of afforestation, with radiata pine becoming the most favoured exotic tree. The State Forest Service was established in 1921.

The government created the Department of Agriculture in 1892 and the Department of Scientific and Industrial Research (DSIR) was established in 1926. Victoria University College in Wellington had founded a Chair of Agriculture in 1923 and Auckland University College had created a School of Agriculture in 1924. In February 1926, these schools combined under the New Zealand Agricultural College Act 1926 and was renamed Massey Agricultural College in 1927 in honour of William Ferguson Massey. This is now Massey University.

In 1921, the Cawthron Institute opened in Nelson as a result of a large bequest from Nelson philanthropist Thomas Cawthron, specifically so that science could contribute to New Zealand's economic growth (see www.cawthron.org.nz/about/our-history/). The science at Cawthron initially focused on the pipfuit and hop growing industries.

The pastoral sector came to dominate exports from New Zealand, particularly wool, frozen meat and dairy products (butter and cheese). This is shown in Figure 3-4. In 1929, 93.7 per cent of exports were contributed by the pastoral sector and 89.6 per cent of the pastoral exports came from wool, frozen meat and dairy products.

Figure 3-4: Value of Pastoral and Other Exports from New Zealand, 1911-1932



Source: *New Zealand Official Yearbook* 1932 and 1934, accessed 21 April 2015 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx.

The figure also shows the collapse in export revenue after 1929 as the world moved into the Great Depression. Total export revenue was £54.2 million in 1929; it fell to £44.2 million in 1930 (a reduction of 18.4 per cent) and to £34.3 million (a reduction of a further 22.4 per cent, or more than one-third in two years). This set the scene for the British Empire Economic Conference in Ottawa in 1932.

Box 3.1: New Zealand's Statutory Marketing Boards

Rodolfo Nayga and Allan Rae (1993) record that New Zealand had five statutory marketing boards representing the country's major export industries:

- The Dairy Board
- The Meat Producers Board
- The Wool Board
- The Apple and Pear Marketing Board
- The Kiwifruit Marketing Board

They describe the three key roles of these boards: (i) regulatory and control functions; (ii) commercial activities; and (iii) leadership and industry servicing activities.

The forerunner of the Dairy Board was the creation of the New Zealand Dairy Export Control Board, established by statute in 1923. The Board aimed to stabilise and increase prices for butter and cheese in the United Kingdom, setting minimum prices for these New Zealand products on the British market. A Dairy Products Marketing Commission was created in 1947, and the two institutions were merged in 1961 and renamed the New Zealand Dairy Board in 1966.

The Meat Producers Board was established in 1922 with power to assume control over all exported meat. The Board established grading standards for export meat, coordinated export flows and undertook some international marketing.

The first effort to regulate the supply of wool to auctions saw the statutory creation of the New Zealand Wool Committee in 1921. This became the Wool Council and then the first New Zealand Wool Board in 1944. This was reconstituted in 1977 with substantial legislative powers that were generally not used.

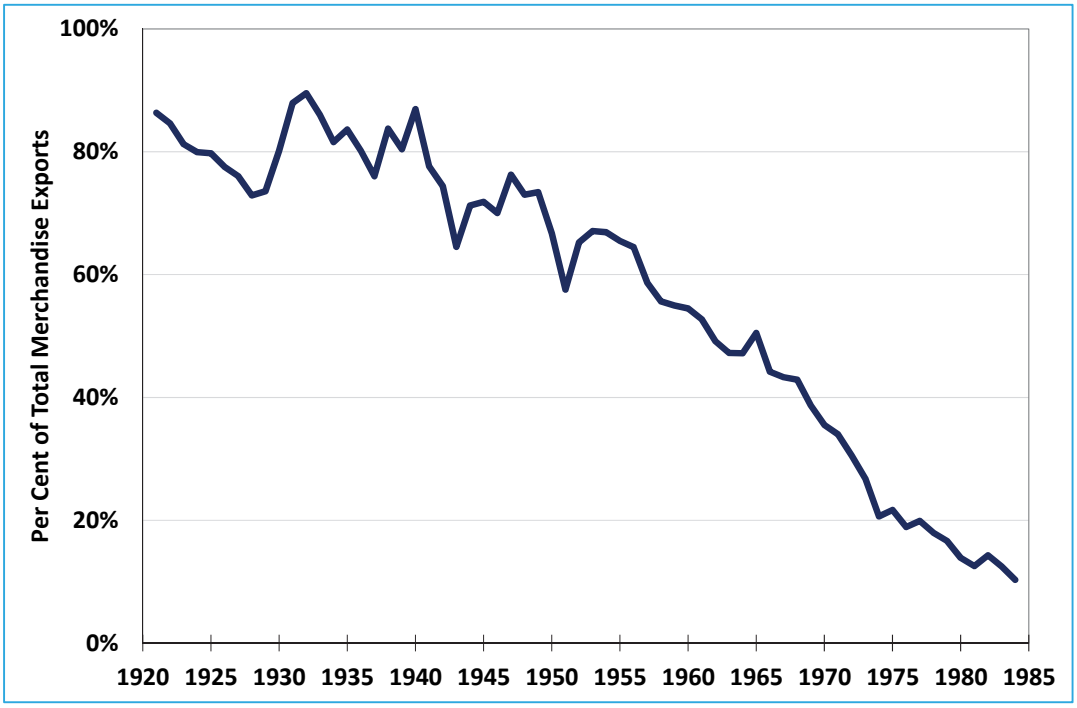
The Fruit Export Control Board was established in 1926 with the sole right to export pip fruit. This function was taken over by the government's Internal Marketing Division during the late 1930s before the creation of the New Zealand Apple and Pear Marketing Board in 1948.

Kiwifruit developed much later that these previous industries. A voluntary body of growers set up the Kiwifruit Export Promotion Committee in 1970, which was replaced by the statutory Kiwifruit Authority to licence exporters in 1977. A major downturn in the industry led to the creation of the Kiwifruit Marketing Board in 1989.

3.4 The Ottawa Agreement, 1932

Figure 3-5 depicts a key trend in New Zealand's international trade in the fifty years after the Great Depression. In the 1930s, trade with the United Kingdom remained at around 80 per cent of all New Zealand's merchandise trade, and it was still above 60 per cent in the mid-1950s. That dominance then changed dramatically, so that by the time Britain entered into the European Economic Community on 1 January 1973, diversification by New Zealand exporters meant that the UK share of New Zealand's merchandise trade had fallen to just above 25 per cent. That figure continued to decline and had reached 10 per cent when New Zealand began its decade of economic reforms following the general election of July 1984.

Figure 3-5: Share of Total Merchandise Exports Sent to the United Kingdom, 1921-1984



Note that the data change from calendar years to years ending June from 1959.
Source: *New Zealand Official Yearbook* various years, accessed 21 April 2015 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx.

The section discusses the agri-food sector during the earlier period, when trade with the United Kingdom was strongly shaped by the system of imperial preference set up in the Ottawa Agreement, 1932, and by the war-time and post-war bulk purchase agreements between the United Kingdom and New Zealand governments from 1939 to 1954. Section 3.5 will then discuss the period between 1954 and 1984 as New Zealanders began to create new markets for its agri-food exports, but did not grow as fast (in terms of per capita gross domestic product) as many other developed countries.

It is perhaps difficult from this distance to imagine the huge disruption to international trade that accompanied the Great Depression. Table 3-1 presents data on New Zealand exports in 1928 and 1932. In the space of four years, the value of exports to Australia and to Pacific Island nations halved, while exports to Germany, the United States and Canada fell by between three-quarters and nine-tenths. The loss of trade with the United Kingdom was relatively small, but was still a decline of more than 20 per cent.

Table 3-1: Value of New Zealand Exports, by Destination, 1928 and 1932

	1928 (£000s)	1932 (£000s)	Difference (£000s)	Per Cent (%)
Australia	2,902.7	1,444.9	-1,457.8	-50.2%
Canada	2,469.2	244.2	-2,225.0	-90.1%
Germany	1,290.1	289.9	-1,000.2	-77.5%
Pacific Islands	574.9	265.4	-309.4	-53.8%
United Kingdom	40,510.1	31,344.7	-9,165.4	-22.6%
United States	4,160.3	690.0	-3,470.3	-83.4%
Other Countries	3,663.2	1,330.9	-2,332.4	-63.7%
Total	**55,570.4**	**35,609.9**	**-19,960.5**	**-35.9%**

Source: *New Zealand Official Yearbook* 1940, accessed 21 April 2015 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx.

Imperial conferences of government leaders from the colonies and dominions in the British Empire had been held irregularly since 1887. In 1932, an imperial conference was held in Ottawa held between 21 July and 20 August. This produced the Ottawa Agreement, 1932, which was a series of twelve bilateral trade agreements providing for mutual tariff concessions and some other commitments among the participants, a system known as imperial preference. The New Zealand delegation was led by Finance Minister, Gordon Coates, who made a statement to the House of Representatives on his return (Coates, 1932, p. 2):

> The immediate purpose of the Ottawa Conference, so far as New Zealand was concerned, was to obtain assured markets for our exports, and for these markets we look mainly to the United Kingdom. First, then, we sought continued exemption from the United Kingdom's 10-per-cent revenue tariff. Had it not been for the Ottawa Conference, or had we failed to reach agreement, the tariff would have fallen upon our products imported into the United Kingdom after that date, just a month hence. The first achievement of the Agreement, provided for in Article 1, is that our staple exports are to remain exempt from the tariff.
>
> Moreover, an increased margin of preference, mostly of the order of 15 per cent, instead of the former 10 per cent, is to be granted to many New Zealand exports. This applies to butter, cheese, apples, pears, eggs, milk-products, and honey. On a further substantial list of our exports the margin of 10-per-cent preference over foreign products is to be maintained. The

> 15-per-cent list covers many foodstuffs, the 10-per-cent list covers articles which are the raw materials of British manufacturing industries. A highly valuable provision now conceded by the United Kingdom is that these preferences on New Zealand products are for the most part guaranteed to continue for at least five years.

The Ottawa Agreement expired on schedule in 1937, but even at that stage "the New Zealand and United Kingdom governments had discussed arrangements for the production and shipping of the greatest possible quantity of foodstuffs to feed the people in Britain in the event of war" (Baker, 1965, p. 184). Two years later the United Kingdom was at war; Baker (ibid) records that bulk purchasing agreements for wool, meat, cheese and butter were concluded within two weeks of the outbreak in 1939. As World War II drew towards a close, the bulk purchase contracts were extended for wool for one more year and for meat and dairy until 1948 (idem, p. 525). These meat and dairy contracts were again extended in 1948 for another seven years, although in due course they finished one year early in 1954 (Nixon and Yeabsley, 2012).

Thus between 1932 and 1954, New Zealand large agri-food producers were firmly focused on increasing the quantity of exports to the United Kingdom. The country's research centres were well placed for this effort with large groups of scientists at Lincoln College, Massey Agricultural College, the DSIR, the Department of Agriculture and the Cawthron Institute. The Dairy Research Institute had been founded at Massey in 1927 and the following year had seen the establishment of the Wheat Research Institute in Christchurch and at Lincoln. The New Zealand Wool Manufacturer's Research Association (later the New Zealand Wool Industries Research Institute) began in Dunedin in 1937. At Riwaka, Motueka, the Tobacco Research Station was set up in 1938 and the Hop Research Station in 1949. The DSIR set up the Animal Research Division in 1939. The Meat Industry Research Institute of New Zealand was incorporated in 1955 also situated at Ruakura, Hamilton).[2]

The general approach of the period is well captured by McLaughlan (2006, p. 145), speaking of the Ruakura Animal Research Station:

> The Ruakura group made the paddock their laboratory. If research projects did not apply directly to the business of livestock farming under conditions prevailing in this country, they did not undertake them. They aimed at achieving the highest production per acre at the lowest cost to the farmer.

An example of the changes brought about in industry to increase physical productivity was the move away from Jersey cows to Friesian cows during the 1950s on the basis that the latter produce more milk (Peden, 2012). During the same decade, Ron Sharp in the Waikato invented the herringbone design for milking sheds that allowed more cows to be milked at once by fewer people (Stringleman and Scrimgeour, 2015).

[2] This list of research institutes and their founding dates come from the entry on Science in Industry published in 1966 in *An Encyclopaedia of New Zealand*, edited by A. H. McLintock, accessed 21 April at www.teara.govt.nz/en/1966/science-in-industry. See also McLaughlan (2006, chapter 12) and Galbreath (2013).

Another productivity-enhancing and cost-saving innovation of this period was the introduction of aerial topdressing of fertiliser. The first trials took place in 1948 were at Ōhakea near Palmerston North and the first commercial aerial topdressing was applied in Canterbury on the farm of Sir Heaton Rhodes at Tai Tapu. Maber (2013) records that the calculated cost was less than half of that for manual spreading.

Two new industries had their export origins at around that time. The first exports of Chinese gooseberries to the United Kingdom and Australia occurred in 1952 (Campbell and Haggerty, 2013) and five new paper mills were opened to take advantage of maturing pine forests that had been planted between the wars (Cook, 2012). These new plants were: Penrose, in Auckland, opened in 1951; Kinleith, near Tokoroa in 1953; Tamaki, in Auckland in 1953; Tasman, at Kawerau in 1955; and Caxton, at Kawerau in 1955. Kinleith and Tasman were substantial new enterprises, requiring towns to be built for the workforce and their families at Tokoroa and Kawerau.

3.5 The End of Bulk Purchase with the United Kingdom, 1954

The bulk purchase agreements with the United Kingdom finished one year ahead of schedule "as production recovered in the UK" (Nixon and Yeabsley, 2012). Thus it was no long possible to rely on the British market for future export growth and this new reality was reinforced when the United Kingdom – along with Denmark, Ireland and Norway – applied to enter the European Economic Community in 1961 (although these applications were suspended after France vetoed the UK application). As shown in Figure 3-5 of the previous section, the United Kingdom's share of New Zealand's merchandise trade fell continuously over the three decades between 1954 and 1984.

An early reflection of the new international trade situation was the decision by Director-General of the DSIR, Bill Hamilton, to recommend the funding of a new research institute to focus on the economics (rather than just the production) of agricultural exports. The Agricultural Economics Research Unit was approved by Cabinet and established at Lincoln College under its founding Director, Professor Bryan Philpott, in 1962. The Minister for Scientific and Industrial Research, Hon. Blair Tennent, explained the decision as follows (reported in Driver and Dalziel, 2012, p. 1):

> "The difficulties being experienced in the sale of [New Zealand's] farm products overseas have emphasised the need for more research in agricultural economics. … More detailed information is required to estimate the effects of the changes likely to be brought about by changes in overseas markets and other factors."

These difficulties were not helped by the General Agreement on Tariffs and Trade (GATT), which from its beginnings in 1948 allowed countries to protect domestic farm production through tariffs and quotas on agricultural imports and through production subsidies, at the insistence of United States negotiators (Barkema *et al*, 1989, p. 23). Indeed, this situation was reinforced in 1955 when the United States insisted on obtaining a general waiver for its agricultural restrictions from the provisions of GATT. The resulting distortions in international trade of agricultural products was not begun to be addressed seriously until the Uruguay Round of GATT negotiations launched in September 1986 in Punta del Este, Uruguay.

This was the context for New Zealand efforts to diversify its agri-food exports. An example of an industry-led initiative to reduce dependency on the British market was the Lamb Market Diversification Scheme introduced by the New Zealand Meat Board in 1963. This scheme imposed a penalty on lamb exporters if they did not send 22 per cent of their product to countries where there was no substantial market for New Zealand lamb or a particular class of lamb (McDermott *et al*, 2008, pp. 7-8; Nicol, 2012).

The government also sought to encourage diversification within the context of policies aimed at increasing export revenue. It convened an Agricultural Development Conference in 1963, which concluded that pastoral production and exports could be increased with further investment. The 1963 Budget introduced incentives to encourage this (see Tyler and Lattimore, 1990, p. 65):

- The State Advances Corporation established a specific development loan programme for pastoral farmers;
- Transport and the price of fertiliser were subsidised; and
- Farmers could write-off certain capital expenditure on farm development for tax purposes.

In 1966, significant tax deferral was granted for expanding livestock numbers and in 1971/72 stock retention incentive payments were introduced. Further livestock expansion incentives were announced in the 1976 budget. The 1978 set up a scheme of supplementary minimum prices (SMPs), which determined prices at the beginning of each season for sheep meat, beef, wool and dairy products with the government agreeing to cover any shortfall of world trade prices fell below the minimum levels. That budget also introduced the Land Development Encouragement Loan scheme, offering suspensory or interest-free loans for meeting land development targets.

World prices continued to fall, however, and by 1983 the government had recognised that these subsidies were unsustainable (idem, p. 67). Indeed, Tyler and Lattimore (1990, Table 4-1, pp. 72-73) estimate that the producer subsidy equivalent provided in 1983 to New Zealand agriculture reached 34 per cent, having been just 3 per cent in 1970.

Producers in New Zealand did not simply diversify their destination markets; this was also a period of extensive innovation in the products being sent from New Zealand. In 1956, the first commercial Chinese gooseberry cultivar developed in New Zealand was named Hayward after Auckland nurseryman Hayward Wright. Turners & Growers applied the name Kiwifruit to Chinese gooseberries in 1959.

The first exports of boxed beef were sent to the United States in 1958. The first trial shipments of wild venison were sent to Germany in the 1960s. Corbans made the first major export of New Zealand wine in 1963. Frozen crayfish tails sent to the United States became a lucrative export business in the same year. Charolais semen was imported to introduce exotic beef cattle into New Zealand in 1965.

The first mussel barge was towed into the Marlborough Sounds in 1969, which was the same year that the first licence to farm deer was issued. The Pacific oyster was recognised in New

Zealand waters and took over as the dominant export of shellfish from rock oysters in the early 1970s. Montana wines planted their first sauvignon grapes in Marlborough in 1973 and the first salmon farm was established near Tākaka in 1976.

New Zealand began exporting velvet in the late 1970s. In 1979, the New Zealand Meat Producers Board negotiated a four-year contract to export to Iran lamb that was slaughtered to meet Halal requirements.[3]

Figure 3-6 and Figure 3-7 on the following page show the diversification achieved by New Zealand exporters in just 30 years between 1954 and 1984, both in terms of the products exported and in terms of the country's trading partners.

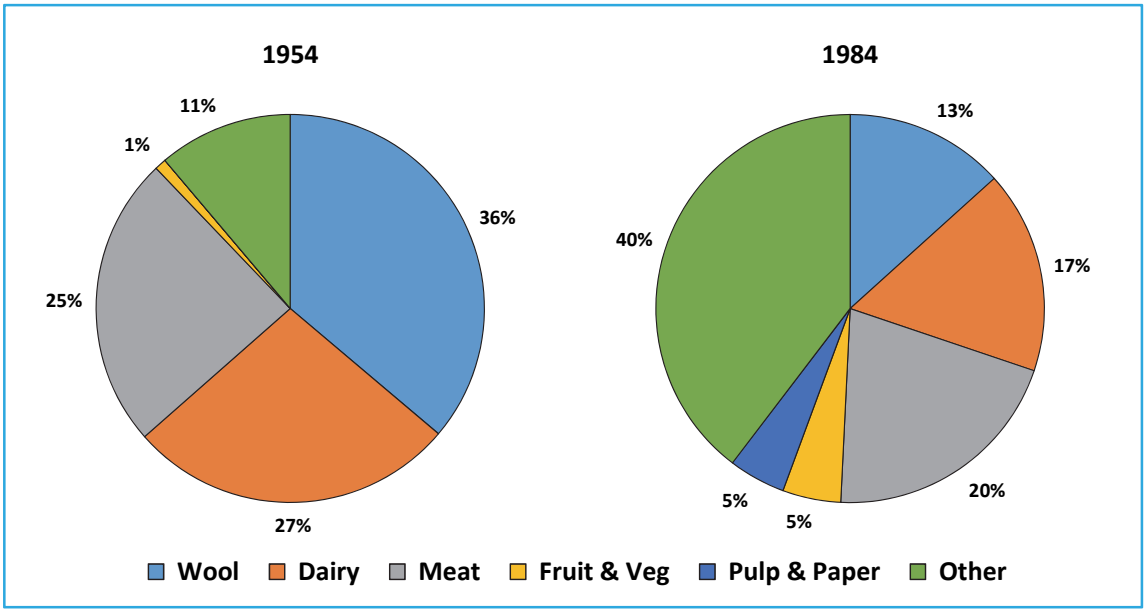
In 1954, 88 per cent of New Zealand's merchandise trade was comprised of wool, dairy and meat products and 67 per cent of the trade was with the United Kingdom. By 1984 those two figures were 50 per cent and 11 per cent. Fruit and vegetables had increased from 1 per cent to 5 per cent, while pulp, paper and paper-board and grown from nothing to 5 per cent in the same period. There had been no trade with Iran in 1954 and almost no trade with Japan. In 1984 these two countries purchased 5 per cent and 16 per cent of New Zealand's merchandise trade respectively. Australia's share had risen from 3 per cent to 15 per cent, and this had been given a further boost when the Australia and New Zealand Closer Economic Relations Trade Agreement entered into force on 1 January 1983.

The range and pace of diversification achieved by New Zealander's exporters prior to 1984 has not always been appreciated. Shane Brownie and Paul Dalziel (1993) undertook a shift-share analysis of this achievement compared to growth in world trade between 1970 and 1984. Although their analysis began in 1970 (rather than 1954), the study's conclusion is relevant for the evidence in Figures 3-6 and 3-7 (idem, p. 247):

> From this analysis a clear picture emerges. New Zealand's 1970 exports were over-concentrated on commodities and countries that grew more slowly in international trade than the world average. Nevertheless, New Zealand's export growth rates in all non-petroleum commodity groups, and to all regions outside the OECD, were considerably higher than would have been anticipated given the situation in 1970 and given international trends over the next fourteen years. Indeed, so impressive were the gains in trade to non-OECD countries, particularly to Asia, China and the Middle East, they would have outweighed the consequences both of the adverse initial endowment and of the relatively poor growth in exports to OECD countries, had it not been for the devastating fall in exports to the United Kingdom following that country's entry into the European Community. Acknowledging these points, the performance of New Zealand's exporters over the period under review is revealed as much more credible than is recognised by analyses relying on aggregate trading figures alone.

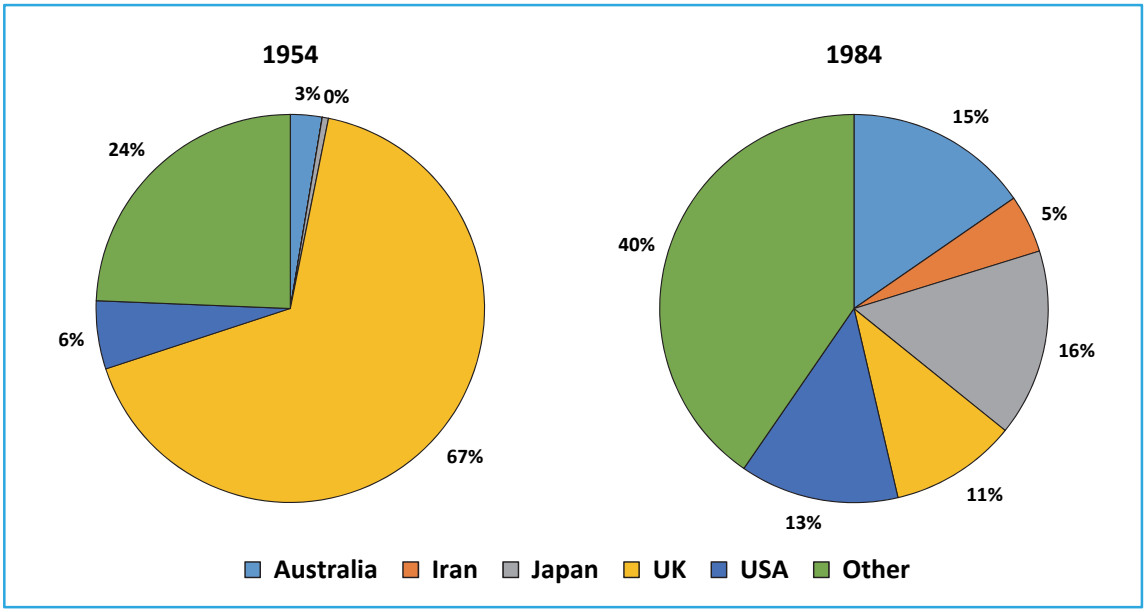
[3] The facts in this paragraph are taken from *Te Ara - The Encyclopedia of New Zealand*, including from the following entries: Campbell and Haggerty (2013); Dalley (2014); Drew (2013); Peden (2013); Walrond (2012); and Wassilieff (2012a, 2012b).

Figure 3-6: Composition of New Zealand Merchandise Exports, 1954 and 1984



Source: *New Zealand Official Yearbook* 1956 and 1985, accessed 22 April 2015 from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/digital-yearbook-collection.aspx.

Figure 3-7: Destination of New Zealand Merchandise Exports, 1954 and 1984



Source: As for Figure 3-6.

3.6 The Economic Reforms, 1984

A change of government in July 1984 heralded a decade of comprehensive economic reform to achieve macroeconomic stability (achieved through monetary disinflation and moving the fiscal deficit into surplus), greater microeconomic competition (achieved through industry deregulation and less government provision of marketable goods and services) and internationalisation of the domestic economy (achieved through floating the New Zealand exchange rate, lowering import barriers and removing subsidies on international prices). The outgoing government had already announced that supplementary minimum prices would end that season; the new government's first budget announced that all forms of assistance to agriculture would be phased out. Some government services previously funded out of general taxation – such as the inspection, animal health and advisory services of the Ministry of Agriculture and Fisheries – moved to a system of user pays, for example, and the Rural Bank was required to move its interest rates to unsubsidised market levels.

Tyler and Lattimore (1990, Table 4-1, pp. 72-73) estimate that by 1990 market-directed policies had lowered the producer subsidy equivalent received by New Zealand agriculture from its peak of 34 per cent back to its historical value of 3 per cent.

These changes do not mean that the government now adopts a hand-off attitude towards the agri-food sector. Export growth continues to be regarded as important for the country's prosperity; the Government's Business Growth Agenda has adopted the objective of exports increasing from 30% to 40% of gross domestic product. The Ministry of Foreign Affairs and Trade, for example, is responsible for negotiating with other governments on conditions of market access for New Zealand goods and services – including its agri-food exports – and for maintaining and enforcing that access. This includes participating in the Doha Round of the World Trade Organization's negotiations that commenced in 2001, which originally aimed to build on the previous Uruguay Round by pursuing an ambitious agriculture mandate for:

- substantial improvements in market access;
- reductions of, with a view to phasing out, all forms of export subsidies; and
- substantial reductions in trade-distorting domestic support.

The Doha Round is struggling to make process, but the Ministry is pursuing other bilateral trade agreements, for example with the Gulf Cooperation Council in the Middle East, with India and with Korea. A major achievement was the signing of the Free Trade Agreement between New Zealand and China on the 7th of April 2008 in Beijing, concluding a negotiation process that had spanned fifteen rounds over three years.

The Ministry for Primary Industries is supporting the Business Growth Agenda target by aiming to double primary industry exports in real terms (from $32 billion in June 2012 to over $64 billion by 2025). It has four interconnected areas of focus, described as follows (accessed 22 April 2015 at www.mpi.govt.nz/about-mpi/our-strategy-2030/our-areas-of-focus/):

Maximise export opportunities

- Export success is enhanced by the integrity of primary sector products and increasing the use of New Zealand's unique culture and brand.
- Exporters have improved access to fast-growing and high-value markets and benefit from new export opportunities.

Improve sector productivity

- Improved generation of new ideas and their adoption and adaptation by the primary industries, including Māori, is supported by government actions.
- The primary industries, including Māori, have greater access to capital and have the skills needed to grow and innovate.

Increase sustainable resource use (and improve sector productivity)

- The primary sector, including Māori, maximises the use and productivity of natural resources within environmentally sustainable limits and is resilient to adverse climatic and biosecurity events.

Protect from biological risk

- The primary sector is protected from biological risks through the effective operation of the biosecurity and food safety systems.

The Ministry is responsible for the Primary Growth Partnership (PGP), which offers significant public investment in long-term innovation programmes with industry to increase the market success of the primary industries. As at 31 October 2014, there were 16 PGP programmes underway and 2 completed programmes. NZIER has estimated that the overall economic impact of PGP from current and future programmes will be $11.1 billion per annum in 2025, with ongoing benefits into the future (Kaye-Blake *et al*, 2014).

One of the 16 programmes can illustrate the PGP principles. The Red Meat Profit Partnership (RMPP; see Beef + Lamb New Zealand, 2014) is a seven-year collaboration between the Ministry and nine industry partners: Alliance Group; ANZCO Foods; ANZ; Beef + Lamb New Zealand; Blue Sky Meats; Greenlea Premier Meats; Progressive Meats, Rabobank and Silver Fern Farms. Beef + Lamb New Zealand, who represent sheep and beef farmers, are investing nearly $20 million in the programme over seven years and the other industry partners are contributed just over $10 million. These investments are being matched by the government, so that the total programme will be funded with $64.3 million over its life.

The RMPP is industry-led, building on the Red Meat Sector Strategy prepared by Deloitte (2011). It explicitly states that "it is not about production for production's sake", but aims "to drive sustainable productivity improvements in the sheep and beef sector to deliver higher on-farm profitability" (idem, p. 3 and p. 2). There are nine elements to what the partnership expects to achieve (idem, p. 6):

- Improve productivity and profitability
- Move farmer focus and thinking from price per kg, to production and profit per hectare
- Focus and develop the fundamentals – specifically in the areas of "planning" and "on-farm operation"
- Enable better farm decision making through benchmarking

- Collaborate will all the industry players
- Attract talent into the industry
- Identify and implement the most efficient pathway for stock from farm to processor
- Deliver a common on-farm quality assurance scheme
- Tell and sell our story

The last of those elements pays particular attention to the industry's export customers: "Make sure New Zealanders, international consumers and others know the red meat sector looks after the environment and has the highest food quality and safety standards" (ibid).

The Ministry of Business, Innovation and Employment manages National Science Challenges, which are eleven research areas identified as having major and enduring benefits for New Zealand. Four of these are particularly relevant for the agri-food sector (accessed 22 April 2015 at: www.msi.govt.nz/update-me/major-projects/national-science-challenges/).

High-Value Nutrition - Ko Ngā Kai Whai Painga

- Develop high-value foods with validated health benefits to drive economic growth

New Zealand's Biological Heritage - Ngā Koiora Tuku Iho

- Protecting and managing our biodiversity, improving our biosecurity, and enhancing our resilience to harmful organisms

Sustainable Seas - Ko Ngā Moana Whakauka

- Enhance utlilisation of our marine resources within environmental and biological constraints

Our Land and Water - Toitū te Whenua, Toiora te Wai

- Research to enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations

These examples of government programmes illustrate how the environment for the agri-food sector has dramatically changed from periods prior to 1984. Commercial success is not guaranteed by imperial preference or domestic subsidies. Rather trade access is achieved through careful and detailed negotiation of mutual interests. Profits by enterprises and industries are achieved through consistent delivering of value to customers in a wide range of international markets. The next chapter explores these developments further by discussing some key international trends affecting the demand for New Zealand exported goods and services from its primary sector.

4. Our Trading Environment is Changing

4.1 Introduction

The previous chapter has described how the history of the country's agri-food production, processing and exporting is replete with examples of New Zealand enterprise creating and capturing value through the interaction of four key elements:

- Changes in international trade;
- Developments in domestic industries and policies;
- Innovations in science and technology; and
- Creations of trusted commercial brands.

The future success of the sector will build on that history but is not guaranteed by it. Important trends are occurring in global markets that are likely to affect New Zealand's land-based enterprises, offering opportunities but also presenting some challenges. It is not possible to discuss all of these trends, which vary in different markets (both for different products and in different parts of the world). Instead, this chapter focuses on four key trends that were identified in discussions with this project's advisory board and with industry partners in other AERU research programmes. These trends are also chosen because they can be analysed further using AERU tools such as the Lincoln Trade and Environment Model and its international market watch activities. This analysis is presented in chapter 5.

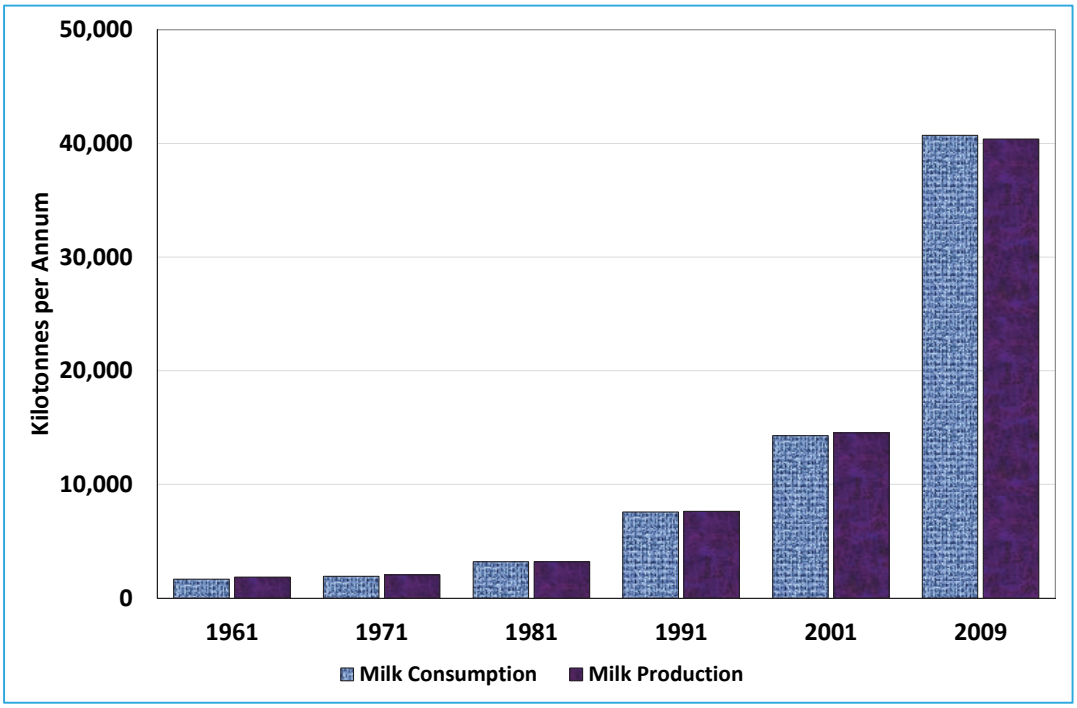
The four key trends discussed in this chapter are: (1) growth in global agricultural production; (2) increased market segmentation and consumer targeting; (3) movements towards greater trade liberalisation in agri-food products; and (4) an expanding range of biosecurity threats to agri-food production.

4.2 Growth in Global Agricultural Production

Demand for food and other land-based products continues to grow globally as a result of factors such as population growth, some successes in reducing poverty in line with the United Nations Millennium Goals, expanding middle classes in many developing countries and rising incomes in developed countries. This offers opportunities for an agri-food exporting country like New Zealand. Nevertheless, supply is also growing globally, which increases competition and so tends to reduce producer returns.

Figure 4-1 illustrates these trends with a topical example for New Zealand. It shows the consumption of milk and the production of milk in China from 1961 to 2009. The former has increased dramatically, by a factor of nearly 25 times over the five decades. The figure also shows, however, that domestic production in China has kept pace with that growth.

Figure 4-1: Milk Consumption and Milk Production in China, 1961-2009



Source: FAOSTAT data, reported in Guenther (2014), Table 2.10 and Table 2.13.

Growth in global agricultural production is driven primarily by investment in new technologies and increases in land productivity, both based on science and innovation (OECD FAO, 2012, p. 51). Agricultural productivity can be difficult to measure and indeed there is a variety of indicators, sources and estimation methods available. As mentioned in section 2.3, total factor productivity is generally the most accurate measure of productivity growth as it accounts for all relevant inputs (Ludena *et al*, 2007). Consequently, Table 4-1 shows total factor productivity growth rates in agriculture in world regions between 1961 and 2009 estimated by the OECD FAO (2012).

Table 4-1: Total Factor Productivity Growth Rates in Agriculture in World Regions (Per Cent Per Annum), 1961-2009

Country/Region	1961-1970	1971-1980	1981-1990	1991-2000	2001-2009
All developed countries	1.0	1.6	1.4	2.2	2.4
All developing countries	0.7	0.9	1.1	2.2	2.2
Brazil	0.2	0.5	3.0	2.6	4.0
China	0.9	0.6	1.7	4.2	2.8
South Asia (including India)	0.6	0.9	1.3	1.2	2.0

Source: OECD FAO (2012).

Between 1961 and 1980, developed countries achieved a higher productivity growth rate in agriculture (sometimes called the green revolution), but that advantage has closed in the last three decades. Productivity growth has been particularly high in Brazil, averaging 3 per cent per annum in the 1980s and 4 per cent after 2000. Growth in China has also been above the average of developed countries, peaking at above 4 per cent in the 1990s.

Projections have generally expected agricultural productivity to continue growing in the future (FAO, 2002; Ludena *et al*, 2007). Table 4-2 records estimates made by the FAO in 2012 for the period to 2030 and from 2030 to 2050. These suggest that global agricultural productivity would grow at 1.3 per cent per annum in the first period and at 0.8 per cent in the second period, with developing countries increasing productivity at a higher rate than developed countries.

Table 4-2: Projected Agricultural Productivity Growth Rates by Type and in Different Regions (Per Cent Per Annum), 2030-2050

	Meat		Dairy		Total Agriculture	
Region	**2005/07 to 2030**	**2030 to 2050**	**2005/07 to 2030**	**2030 to 2050**	**2005/07 to 2030**	**2030 to 2050**
Developing countries	2.1	1.7	2.1	1.8	1.6	0.9
Developed countries	0.7	0.5	0.5	0.3	0.7	0.3
World	1.5	1.3	1.3	1.1	1.3	0.8

Source: FAO (2012, pp. 74-75).

For New Zealand, Hall and Scobie (2006, p. 1) have observed that agricultural productivity growth is also driven by research and innovation that improves and intensifies farming practices and technology. As described in section 2.3, these authors estimate that multifactor productivity for the land based sector was 2.6 per cent between 1983/84 and 2000/01. Between 2001 and 2012 agricultural productivity growth was similar to the average of the country's wider measure sectors, peaking in 2005/06 (see also Figure 2-9 and the accompanying discussion in chapter 2 of this report).

Irrigation infrastructure

An example of how science and investment increases land productivity is the use of irrigation to intensify land use, for example by making feasible the conversion of sheep and beef farms to dairy production and allowing greater production (Robertson, 2010). Irrigation contributes to the New Zealand economy in a number ways. First, it increases agricultural production which in turn lifts producer returns. Second, this increased production draws in additional inputs such as agricultural services and transport. Third, these additional on-farm volumes lead to more activity in processing industries. Furthermore, irrigation is likely to create higher employment, wages and returns to capital and land, which as a consequence will increase household spending on other goods and service (NZIER, 2014, p. i).

There have been specific studies on the value of irrigation in a New Zealand context. Grimes and Aitken (2008), for example, found that irrigated farms in the Mackenzie District of Canterbury sold for up to 50 per cent more than similar unirrigated farms). Kaye-Blake *et al*. (2010, pp. 13-16) expected 270,000 ha of additional irrigation from planned irrigation schemes in Canterbury, and 71,000 ha in the Wairarapa and Hawke's Bay, as shown in Table 4-3. The study estimated that a total additional 370,000 ha of irrigated land in Canterbury would result in $2.4 billion in added farm-gate production, which was an increase of $6,028 per hectare of irrigated land. In contrast, for Hawkes Bay the increase was estimated at $1,316 per hectare, from $2,010 to $3,326 per hectare. These results reflect a dairy pay-out of $5.50 per kg of milk solids used in the study. Saunders and Saunders (2012) estimated that an increase of 250,000 hectares in irrigated land for additional dairying, more intensive sheep and beef, and arable in Canterbury would result in an additional value added of approximately $500 million. Input-output tables for Canterbury suggested that this change in dairying would be associated with extra value added in dairy product manufacturing of $1,068 million.

Table 4-3: Planned Irrigation Schemes 2013-2024

Scheme	Area (Ha)	First Water Flows
Te Pirita Irrigation Ltd - (CPW Stage 1)	6,000	2013
TrustPower Coleridge Stage 1 (includes CPW Stage 2)	20,000	2013
Hawkes Bay Ruataniwha Stage 1	17,000	2015
Hawkes Bay Ngaruroro	10,000	2016
Hunter Downs	40,000	2017
TrustPower Coleridge Stage 2 (provides CPW Stage 3)	42,000	2017
Hawkes Bay Tutaekuri	8,000	2018
Hurunui - Waiau New Option	42,000	2019
Hawkes Bay Ruataniwha Stage 2	6,000	2019
Lees Valley	120,000	2022
Wairarapa Stage 1	14,000	2018
Wairarapa Stage 2	8,000	2022
Wairarapa Stage 3	8,000	2024

Source: MAF.

4.3 Market Segmentation and Consumer Targeting

Internationally, a growing world population, urbanisation and rising incomes have led to increased food consumption. In developing countries, the growth in food consumption has been accompanied by shifts in dietary patterns away from staples towards more livestock products (OECD FAO, 2012). Table 4-4 shows changes of food consumption for key product categories in world regions between 1961 and 2009. It can be seen that Asian countries increased their meat and milk consumption during that period and China recorded significant increases in meat and milk consumption over the past five decades.

Table 4-4: Consumption of Key Food Categories by Region, 1961-2009

Region	Food	Thousands of Tonnes						Change 1961 to 2009 (%)
		1961	1971	1981	1991	2001	2009	
World	Cereals	390,527	503,857	643,999	793,437	896,827	976,681	150.1
	Eggs	13,880	19,228	25,022	34,692	49,715	59,291	327.2
	Meat	70,062	102,287	136,170	179,762	231,747	278,863	298.0
	Milk	229,546	280,167	341,593	402,712	477,796	580,868	153.1
Africa	Cereals	34,887	45,631	64,530	87,719	113,664	141,037	304.3
	Eggs	328	509	871	1,327	1,700	2,176	564.1
	Meat	3,732	4,816	6,879	9,120	11,753	16,393	339.2
	Milk	8,918	12,884	19,617	22,460	30,957	40,909	358.7
North America	Cereals	18,031	18,796	22,270	30,662	36,498	37,197	106.3
	Eggs	3,620	4,034	3,862	3,734	4,569	4,730	30.7
	Meat	18,222	25,093	27,638	31,932	37,911	40,155	120.4
	Milk	54,892	56,643	60,801	71,966	81,142	85,413	55.6
Asia	Cereals	203,780	297,319	402,533	508,095	582,488	626,360	207.4
	Eggs	3,117	5,086	7,417	15,496	29,758	37,071	1,089.1
	Meat	8,811	18,149	30,542	55,965	96,429	124,531	1,313.4
	Milk	36,619	46,376	69,469	102,450	153,976	220,282	501.6
Europe	Cereals	108,293	107,658	107,896	110,596	96,627	96,704	-10.7
	Eggs	5,843	8,084	10,366	10,507	8,974	9,334	59.7
	Meat	30,527	43,117	54,032	60,649	52,192	56,294	84.4
	Milk	110,624	137,118	154,148	160,033	151,451	161,661	46.1
China	Cereals	61,584	111,185	160,307	196,005	209,423	206,682	235.6
	Eggs	1,388	1,801	2,731	8,638	20,442	25,201	1,715.9
	Meat	2,562	8,578	15,348	32,869	63,607	79,460	3,001.4
	Milk	1,661	1,916	3,190	7,567	14,283	40,714	2,350.5
India	Cereals	63,431	79,236	105,221	142,701	155,407	173,602	173.7
	Eggs	144	267	520	1,029	1,831	2,760	1,813.2
	Meat	1,695	2,068	2,654	3,797	4,266	5,339	215.0
	Milk	17,476	19,557	29,277	45,801	66,078	87,256	399.3

Source: FAOSTAT (2013).

Food consumption is projected to continue growing in the future. The latest OECD FAO *Agricultural Outlook* predicts that by 2024 global consumption of beef and veal, and of sheep meat, will increase by 11 per cent and 23 per cent respectively (OECD FAO, 2015, p. 120). Similarly, global dairy consumption is predicted to increase by 18 per cent by 2024.

This increase is mainly driven by developing countries where dairy consumption is projected to increase by 30 per cent by 2024, and beef consumption by 15 per cent, reflecting further globalisation of diets (OECD FAO, 2015). These dietary changes in developing countries are generating changes in consumption, production and trade patterns in other countries. Guenther (2014), for example, has shown that if meat and dairy consumption and production patterns in India and China were to develop as predicted by the OECD FAO Agricultural Outlook (2013) New Zealand producer returns from skim milk powder would increase by 10 per by 2020 cent and those from sheep meat would increase by 9 per cent in the same period.

The growth in the level and diversity of agri-food consumption creates opportunities for increased market segmentation and consumer targeting. These are important mechanisms for capturing value by marketing products with different attributes to different groups of consumers with diverse preferences. Different supermarket chains target different types of consumers, for example, and within any supermarket there is a wide range of products appealing to people with different tastes and values.

This has implications for a small agri-food exporting country like New Zealand. Even in products where it has a large share of international trade (some dairy products such as whole milk powder, for example), it has only a very small share of global production. Consequently, it is sensible for New Zealand exporters to target international consumers who put the highest value on attributes associated with New Zealand produce. These attributes include obvious physical features such as appearance, taste and texture, but also what are termed credence attributes of the product (such as food safety, nutritional value, GM-free, and specific health benefits) or its production system (such as animal welfare, environmental protection, social wellbeing and cultural authenticity). Credence attributes are qualities accepted by a consumer to be present in a product even though they are not able to be directly observed either at the time of purchase or at the time of consumption. The AERU at Lincoln University has recently reviewed the international research on credence attributes (Miller *et al*, 2014), which identified more than 20 market studies since 2010 with evidence of high willingness-to-pay for these credence attributes (Aguilar and Cai, 2010; Brooks and Lusk, 2010; Olynk *et al*, 2010; Steiner *et al*, 2010; Xu and Wu, 2010; Zhang *et al*, 2010; Abidoye *et al*, 2011; Gadema and Oglethorpe, 2011; Lagervist and Hess, 2011; Tonsor, 2011; Zhao and Wu, 2011; Aizaki *et al*, 2012; Janssen and Hamm, 2012; Ortega *et al*, 2012; Toma *et al*, 2012; Bai *et al*, 2013; Koistinen *et al*, 2013; Liu et *al*, 2013; Wang *et al*, 2013; Zheng *et al*, 2013; Grunert *et al*, 2014).

The AERU has provided evidence that consumers in different countries are willing to pay a premium for credence attributes in New Zealand food products (Saunders *et al*, 2013; Saunders *et al*; 2015a and 2015b; Tait *et al*, 2015). This research has shown that the levels of premiums available differ by country, product and attribute (although in all cases 'food safety' ranked very highly), so that it is possible to undertake sophisticated consumer analysis to identify opportunities for greater returns to New Zealand producers and processors.

Willingness to pay for food attribute certification in China, India and the UK

To provide an example of this analysis, a three-country study by the AERU aimed to assess consumers' willingness to pay for the certification of certain food attributes in lamb and dairy products (Saunders *et al*, 2013). The three countries were China, India and the United Kingdom

(UK) and the analysis involved a choice experiment based on the discrete choice modelling approach (Hanley *et al*, 2001; Hensher *et al*, 2005; Greiner *et al*, 2014; and Miller *et al*, 2015). Survey participants were asked: "Compared to the lamb [or dairy products] you normally buy, which of the three types of lamb [or dairy products] below would you prefer at the price indicated?" The examples that they were asked to consider differed in their credence attributes, including certification for food safety, farm animal welfare, water pollution minimisation, greenhouse gas minimisation, biodiversity enhancement, foreign country of origin and New Zealand country of origin.

Based on their choices, the discrete choice modelling methodology allows estimates to be made of the willingness to pay for the different attributes using the method of Krinsky and Robb (1986, 1990). The estimates are presented in Table 4-5. Overall, UK participants were less willing to pay extra for product certification than Chinese or Indian respondents; this again may be due to current standards already in place in the food available to UK consumers. UK participants showed the highest willingness to pay for animal welfare certification in lamb products. They would pay 22 per cent more than the normal price for the lamb product with such certification.

Chinese respondents showed the highest willingness to pay for food safety certification in dairy products. Respondents were willing to pay 74 per cent more than the normal price. In contrast, Indians showed the highest willingness to pay for food safety certification in lamb products for which they would be willing to pay an extra 77 per cent. Chinese had the lowest willingness to pay for lamb products that were certified of not being from China, they were only willing to pay an additional 10 per cent. In comparison, Indian respondents required a 20 per cent price reduction for dairy products that are certified of being from other countries than India. Similarly, UK respondents required a 5 per cent price discount for lamb products that were not produced in the UK.

Table 4-5: Food Attribute Willingness to Pay as a Percentage of Product Price in China, India and the United Kingdom

	China		India		United Kingdom	
	Dairy	Lamb	Dairy	Lamb	Dairy	Lamb
Safety	74%	44%	73%	77%	16%	18%
Animal Welfare	26%	13%	42%	41%	17%	22%
Water	16%	12%	19%	26%	3%	7%
Greenhouse Gases	25%	14%	38%	39%	7%	7%
Biodiversity	22%	15%	27%	42%	6%	6%
Foreign Origin	26%	10%	-20%	-	-4%	-5%
New Zealand Origin	49%	24%	10%	21%	3%	6%

Source: Saunders *et al*. (2013).

Based on these estimates, Saunders *et al*. (2013) calculated that product certification for food safety, animal welfare and biodiversity enhancement of sheep meat and dairy exports to China, India and the UK could increase New Zealand producer returns by more than US$405 million to 2020.

4.4 Greater Trade Liberalisation in Agri-food Products

Chapter 3 explained how from its beginnings in 1948 the General Agreement on Tariffs and Trade (GATT) allowed countries to protect domestic farm production through tariffs and quotas on agricultural imports and through production subsidies. In other goods and services, GATT has achieved reductions of the average tariff among member countries from about 40 per cent in the 1940s to about 5 per cent in 2007 (Mankiw, 2007; Salvatore, 2005), but the exclusion of agricultural trade from this trend was reinforced in 1955 when the United States was granted a general waiver from the provisions of GATT for its agricultural policy. Trade in agri-food products is crucial for New Zealand's economic prospects and indeed New Zealand places few barriers on trade compared to other countries, particularly on agricultural commodities.

One of the most ambitious rounds of GATT multilateral trade negotiations was the Uruguay Round (1986-1994) with 123 countries participating (Salvatore, 2005). It covered a wide range of trade issues with a central issue being the hope of reducing trade barriers for agricultural commodities. This was the first time that agricultural trade was the focus of negotiations (Hawkes and Murphy, 2010; Reinert, 2012) and it opened the way for further reductions in tariffs during subsequent rounds of negotiations. Furthermore, the Uruguay Round addressed not just tariffs but also aimed to reverse the trend of rising non-tariff trade barriers that had increasingly affected agricultural sectors in developed countries. The growth in non-tariff barriers had progressively affected New Zealand's trade, including the existence of quotas for exports into markets of developed countries (MAF and MFAT, 2003).

The Uruguay Round Agreement on Agriculture came into effect in 1995, after which food became part of trade agreements (Hawkes and Murphy, 2010; Salvatore, 2005). The Agreement set the standard of how agriculture was to be implemented in regional and bilateral trade agreements. The goals were to improve market access for agricultural commodities, to reduce domestic support for the agricultural sector in terms of price-distorting subsidies and quotas, to remove export subsidies on agricultural products successively, and to harmonise sanitary and phytosanitary measures between member countries (Hawkes and Murphy, 2010).

Another major reform initiated by the Uruguay Round was the creation of the World Trade Organization (WTO) to replace GATT. The new organisation came into force in 1995 after subsequent ratification by the United States and other member countries on establishing new global trading rules (Mankiw, 2007). The WTO has several functions. It provides a forum for governments to negotiate and formalise trade agreements, it administers trade agreements and attempts to resolve trade disputes aimed at enforcing participants' adherence to WTO agreements which are signed by representatives of member governments (WTO, 2012). Most of the issues that the WTO focuses on derive from previous trade negotiations, especially from the Uruguay Round.

Since its creation, the number of regional arrangements reported to the WTO has risen frequently. As of 7 April 2015, 612 regional and bilateral trade agreements had been notified to the WTO, of which 406 were in force accounting for more than 97 per cent of global trade (WTO, 2015). As mentioned in section 3.6 of the previous chapter, New Zealand is a participant in the current WTO multilateral trade negotiations round that began in Doha in 2001 involving more than 150 countries. Its overall aim was to reduce global trade barriers, but again agriculture has proved to be a contentious issue (Hawkes and Murphy, 2010; Wolfe, 2015).

As well as its involvement in multilateral agreements, New Zealand has negotiated several bilateral trade agreements with a recent focus on free trade agreements (FTAs) to enhance trade and economic growth. This includes free trade agreements with Malaysia (2010), China (2008), ASEAN-Australia (2010) and Korea (2015) with several more under negotiation. New Zealand has also negotiated Closer Economic Partnership Agreements with Singapore (2001), Thailand (2005) and Hong Kong (2011) (MFAT, 2015).

In 2008, New Zealand was the first OECD economy to sign a comprehensive Free Trade Agreement with China. Negotiations took place over a period of four years and the agreement came into force in October 2008. The FTA between China and New Zealand provided for the removal of tariffs on 96 per cent of traded goods over a 12-year-period, fully coming into force in 2019 (MFAT, 2008). The signing of the FTA enhanced trade between the two countries and since 2010, China has been New Zealand's main export market for agricultural commodities. In 2014, the export value of New Zealand's agricultural exports to China was valued at NZ$8.4 billion – a 64 per cent increase from the previous year (Statistics New Zealand, 2014; see also the discussion in section 2.3 earlier in this report).

The most recent FTA signed was between New Zealand and Korea in 2015. Tariff reductions under this agreement are hoped to save an estimated NZ$65 million in duties in the first year. Duties on New Zealand's trade in goods and services between the two countries will largely be eliminated within 15 years of entry into force. Once translated, signed and ratified, the FTA will enter into force, probably in late 2015 or early 2016. (Freer, 2015).

Other Asian countries such as Indonesia and India have some trade with New Zealand and have been identified as potential growth markets for the future. In particular, New Zealand's trade relationship with Indonesia has been given impetus by the ASEAN,[4] Australia and New Zealand Free Trade Agreement (AANZFTA), which Indonesia joined as a member in January 2012 (MFAT, 2014). New Zealand started negotiations towards a free trade agreement with India in 2010, hosting the ninth round of negotiations in 2013. New Zealand is also heavily involved in current trade negotiations on the Trans-Pacific Partnership (TPP) which aims to create a regional free trade agreement between 12 Asia Pacific countries building on the success of the Asia-Pacific Economic Cooperation (APEC) forum of 21 Pacific Rim countries.[5]

[4] ASEAN is the Association of Southeast Asian Nations.

[5] The 12 countries are Australia, Brunei Darussalam, Canada Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, United States of America and Vietnam. The other APEC countries are China, Chinese Taipei, Hong Kong, Indonesia, Papua New Guinea, Philippines, Republic of Korea, Russia and Thailand.

Trade liberalisation creates opportunities for New Zealand producers, but for producers in other countries as well. Recent policy initiatives have seen the removal of milk production quotas in the European Union, for example, with several European countries announcing their intention to increase their milk production. Ireland has plans to double its milk supply. Moreover, in response to these policy changes and demand growth investment in whole milk powder production has increased. In particular, Europe and the United States are increasing capacity but also in Australia and Africa which will compete with New Zealand supply.

4.5 Biosecurity Threats to Agri-food Production

New Zealand's isolation from the world's major population centres poses challenges to its international prospects (McCann, 2009), but it also means that the country is largely free of many pests and diseases found in other countries. The large share of exports from its agri-food sector makes New Zealand vulnerable to biosecurity risks that are addressed by the Ministry of Primary Industries (see www.mpi.govt.nz/law-and-policy/legal-overviews/biosecurity/biosecurity-2025/) using principles such as equivalence and co-management (see www.biosecurity.govt.nz/regs/cont-carg/equivalence-co-management). This includes the creation of protocols that incur a current cost for known risks such as BSE, but which will reduce future costs if a biosecurity incursion does occur. Hence this chapter concludes with three examples illustrating the potential economic impacts of biosecurity incursions.

PSA-V

A major biosecurity incursion in recent years was the PSA-V disease first found in New Zealand kiwifruit orchards in November 2010. The bacterial disease, *Pseudomonas syringae pv actinidiae* (PSA-V) was detected initially in the Bay of Plenty but spread widely throughout the whole of New Zealand's North Island. In July 2015, the number of PSA-V positive orchards was 2,721 or 83 per cent of all orchards nationally; and 87 per cent of the hectares on kiwifruit orchards now contain at least some infected trees (Kiwifruit Vine Health, PSA Statistics, 9 July 2015).

A similar strain of the disease is known to have severely damaged the kiwifruit industry in the Latino region of Italy, so that it is likely to have come from overseas. In the early stages of the outbreak the New Zealand government contributed $25 million for the management of the disease. This was only part of the impact, however; Greer and Saunders (2012) estimated that PSA-V might cost the kiwifruit industry between $310 and $410 million in net present value terms to 2016. By 2026, the estimated costs were estimated to increase to approximately $500 to $600 million and by 2031 to between $740 and $885 million. These costs included the immediate impact on net industry returns of the disease outbreak and of delays in expected industry development in the longer term.

Foot and Mouth disease

Foot and Mouth disease (FMD) is considered to be the most significant biosecurity threat to the New Zealand economy, with potential economic impacts of any incursion estimated to be in the order of billions of dollars (Forbes and van Hladeren, 2014). FMD is a highly contagious viral disease that can infect cattle, sheep, pigs, goats, buffalo all species and many species of

cloven-hoofed animals. The highly infectious virus can be transmitted through air, close contact and feed, and it can survive on tools, equipment and vehicles and in some processed meats (Ministry for Primary Industries, 2011).

New Zealand is recognised by the World Organisation for Animal Health (OIE) as an FMD-free country where vaccination is not practised. The spread of FMD virus is well understood and it occurs most commonly via the movement of live ruminants and pigs, and less commonly by the movement of meat and meat products. The FMD virus is an unwanted organism under the New Zealand Biosecurity Act 1993 and as a notifiable organism the Ministry for Primary Industries (MPI) must be informed when a case is suspected.

The disease has serious economic and social implications for countries producing and exporting livestock and their products. When countries have an outbreak of FMD their livestock export products become subjected to trade bans in order to reduce the risk of transmission to livestock in other countries (Buetre *et al*, 2013). While the risk of an outbreak is considered low in New Zealand, the impact would be severe. Understanding the potential economic cost is an important aspect and has been assessed in a few studies. In 2002, the total costs of an FMD outbreak were estimated by the Reserve Bank of New Zealand to be approximately $6 billion cumulative loss to GDP after one year and $10 billion after two years (Reserve Bank and Treasury, 2002). In a more recent study, Forbes and van Hladeren (2014) estimated that the immediate loss from export earnings from the dairy and the meat sector could be more than to $8.5 billion.

Clover Root Weevil

The clover root weevil (*Sitona lepidus*) is a pasture pest native to Europe which was discovered in the Waikato region of New Zealand in 1996, but then spread across the North Island (Gerard *et al*, 2007) and South Island (Ferguson *et al*, 2012). Small plot trials in Waikato showed that prolonged larval damage weevil caused around 34 per cent reductions in clover annual dry matter yields, providing evidence in support of farmer perception *Sitona Lepidus* is a major pest species (Gerard *et al*, 2007). A study by the New Zealand Institute of Economic Research estimated that with no farmer response, the clover root weevil might cost $419 million per year, which was expected to reach $1 billion by 2017 as the weevil spread nationwide (Wear and Andrews, 2005).

4.6 Conclusion

In summary, this chapter has presented several national and international trends that are likely to affect New Zealand's land based sectors. These developments are leading to changes in consumption, production and trade patterns in New Zealand and elsewhere. They therefore present potential opportunities but also challenges for New Zealand's land based sectors. The following section will assess the potential impacts of these in more detail by using the Lincoln Trade and Environment Model (LTEM) to project trade, production and consumption of agricultural commodities for different futures in New Zealand.

5. Where We Might Go Next

5.1 Introduction

The previous chapter has described four key trends affecting New Zealand agri-food exporters: (1) growth in global agricultural production; (2) increased market segmentation and consumer targeting; (3) movements towards greater trade liberalisation in agri-food products; and (4) an expanding range of biosecurity threats to agri-food production. The purpose of this chapter is to evaluate how significant these effects might be.

The starting point for this analysis is the recognition that changing production, consumption and trade patterns (nationally and internationally) will alter New Zealand's production and trade of commodities from its land based sectors. This will affect producer returns in different ways, depending on the net effects of the inter-connected changes both between markets and commodities. Consequently, it is necessary to model these effects to obtain insights into their relative strengths under different scenarios.

The model used in this report is the Lincoln Trade and Environment Model (LTEM), which has been developed by the AERU at Lincoln University based on the VORSIM model created in the United States for the Uruguay Round of GATT (Roningen, 1997; see www.vorsim.com). LTEM is a multi-country, multi-commodity, partial equilibrium framework that focuses on the agricultural sector (Cagatay and Saunders, 2003). It has a specific focus on New Zealand and its main trading partners, key trading commodities and domestic agricultural policies. The model disaggregates agricultural commodities, especially for dairy and oilseeds, and offers flexibility and transparency for adding variables, equations, policies and data. It currently covers the 23 commodities and the 23 countries listed in Tables 5-1 and 5-2 respectively.

Table 5-1: Commodity Coverage in the Lincoln Trade and Environment Model

Wheat	Oilseed meals	Poultry	Liquid milk
Maize	Vegetable oils	Eggs	Apples
Other grains	Beef and veal	Butter	Kiwifruit
Rice	Pork	Cheese	Grapes
Sugar	Sheep meat	Whole milk powder	Wine
Oilseeds	Wool	Skim milk powder	

Table 5-2: Countries in the LTEM

Argentina	European union (28)	New Zealand	Switzerland
Australia	India	Norway	United States
Brazil	Indonesia	Paraguay	Turkey
Canada	Japan	Russia	Uruguay
Chile	Republic of Korea	Singapore	Rest-of-World
China	Mexico	South Africa	

The LTEM framework generally includes six behavioural equations and one economic identity for each commodity in each country. These behavioural equations are:

- domestic supply;
- domestic demand;
- domestic stocks;
- domestic producer price functions;
- domestic consumer price functions; and
- the trade price equation.

The net trade equation is the central economic identity which is equal to excess supply or demand in the domestic economy. Variation exists for commodities based on the levels of disaggregation. For some commodities, the number of behavioural equations may change as total demand is disaggregated into food, feed, and processing industry demand which is determined endogenously (Cagatay and Saunders, 2003; Saunders *et al*, 2004; Saunders *et al*, 2006). The six key equations are presented in Appendix 2 of this report.

Data in the LTEM includes country specific producer and consumer prices production and consumption beginning and ending stocks, producer and consumer subsidies and taxes, tariffs and quotas. In addition, the LTEM contains population data and GDP figures. In order to determine the effects on supply and demand, productivity growth rates, GDP growth rates and population growth rates are included. The base year of the model is 2012 and it projects out to 2024. In the model, elasticities determine the responsiveness of domestic supply and demand to changing prices, production and consumption patterns, or policy measures.

A list of the main modelling specifications of LTEM are summarised in Table 5-3, drawing on Cagatay *et al*. (2003). The main purpose of the model is to analyse *differences* in outcomes as a result of different **scenarios** designed by the analyst.

The analyst, for example, might construct a scenario in which the amount of irrigated land in New Zealand increases; LTEM then allows the analyst to determine what impact this would have on producer returns or net trade values in 2024 compared to producer returns or net trade values in the base case with no increase in irrigated land. These impacts are reported as percentage changes on the base case levels.

Table 5-3: Modelling Specifications of the Lincoln Trade and Environment Model

Model	LTEM- Lincoln Trade and Environment Model
Modelling Approach	Partial equilibrium
Temporal Properties	Comparative static (+ short term dynamics through sequential simulation)
Solution Type	Non-spatial, net global trade
Solution Algorithm	Newton's global algorithm
Parameters	Synthetic
Commodity Coverage	23
Country Coverage	22 plus one for Rest of the World
Behavioural Equations (per commodity and country)	Domestic supply • feed • food • processing Domestic demand Stock variation Producer price Consumer price Trade
Economic Identity	Net trade

Source: Cagatay *et al*. (2003).

The structure of this chapter mirrors that of the previous chapter. Each of the following four sections considers in turn one of the four trends identified as important for New Zealand agri-food exporters. These are called **Modelled Futures** and within each of these futures there are one to six scenarios depending on assumptions made about the size of the changes involved. This produced 14 scenarios in total.

For ease of reference, Table 5-4 summarises the Modelled Futures and associated scenarios.

Table 5-4: Modelled Futures and their Associated Scenarios

Modelled Futures		Associated Scenarios	
1	Base	1.1	Business as Usual
2	Greater Trade Liberalisation in Agri-food Products	2.1	25 per cent decrease of global trade barriers
		2.2	50 per cent decrease of global trade barriers
		2.3	75 per cent decrease of global trade barriers
		2.4	100 per cent decrease of global trade barriers
3	Market Segmentation and Consumer Targeting	3.1	20 per cent increased value in developed and developing countries
		3.2	50 per cent increased value in developed and developing countries
4	Market Segmentation with Trade Liberalisation	4.1	20 per cent increased value in select countries, 100 per cent decrease of global trade barriers
		4.2	50 per cent increased value in select countries, 100 per cent decrease of global trade barriers
5	Biosecurity Threats to Agri-food Production	5.1	Outbreak of Foot and Mouth Disease with limited loss of market access
		5.2	Outbreak of Foot and Mouth Disease with loss of market access

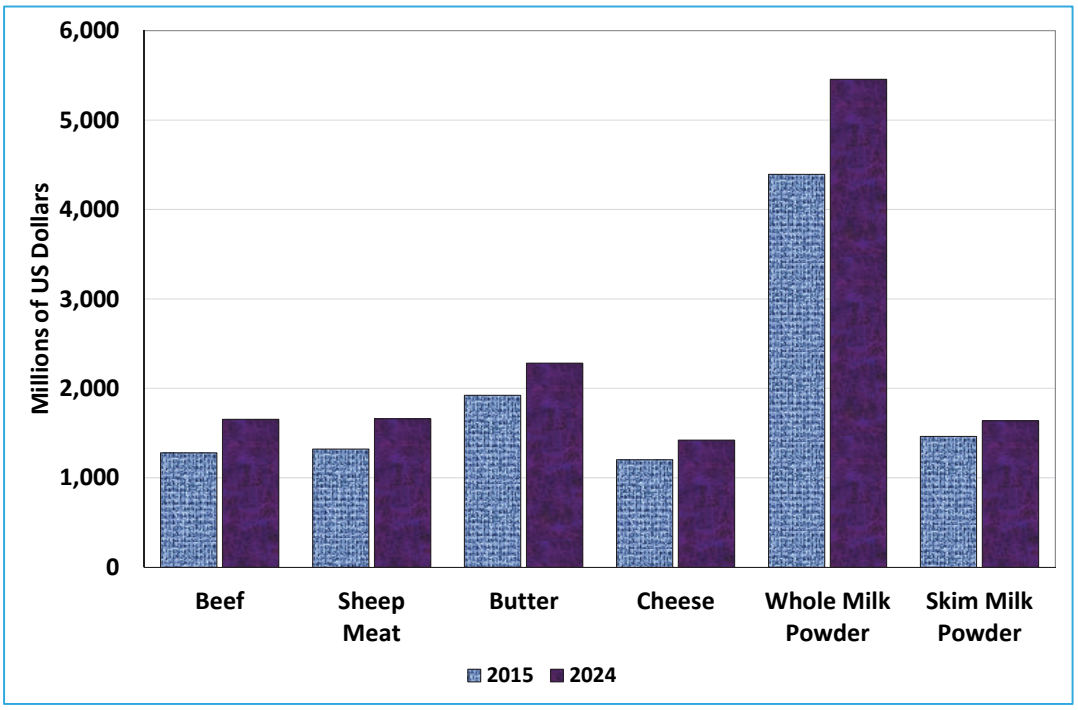
For each scenario, tables are presented to show results on 2024 New Zealand producer returns and 2024 New Zealand net trade valued in millions of United States dollars, along with percentage changes from the base (scenario 1.1) to the scenario in 2024. Producer returns results are shown for three commodities: beef; sheep meat; and raw milk. No raw milk is exported, of course, and so the net trade results replace that commodity with data for butter, cheese, whole milk powder and skim milk powder.

5.2 Business as Usual (Future 1)

The initial task to assess the impact of different futures is to establish a base from which modelled results can be compared, assuming no changes to agricultural trends or policy. This 'business as usual' or 'base' scenario model a possible pathway for the agriculture sector out until 2024 based on official projections of population growth, gross domestic product (GDP) growth and productivity growth. Agricultural productivity rates are derived from FAO/OECD projections of the state of agriculture (OECD FAO, 2015). GDP and population growth rates are derived from the IMF world economic outlook (IMF, 2015). This base analysis does not aim to quantify the precise state of agriculture in a decade; rather it provides a benchmark against which modelled futures can be compared, thus isolating the specific impact of the modelled policies compared to the base scenario outcomes.

Figure 5-1 compares the New Zealand net trade values of meat and dairy products in the first and last years of the base scenario. It shows for all six categories that the net trade value is expected to grow, with the most significant increase being in the trade of whole milk powder. These figures illustrate that with no major changes to agricultural policy, market access or practice, New Zealand agri-food exports are expected to increase over the next decade.

Figure 5-1: New Zealand Net Trade Value of Selected Exports, Future 1, 2015 and 2024

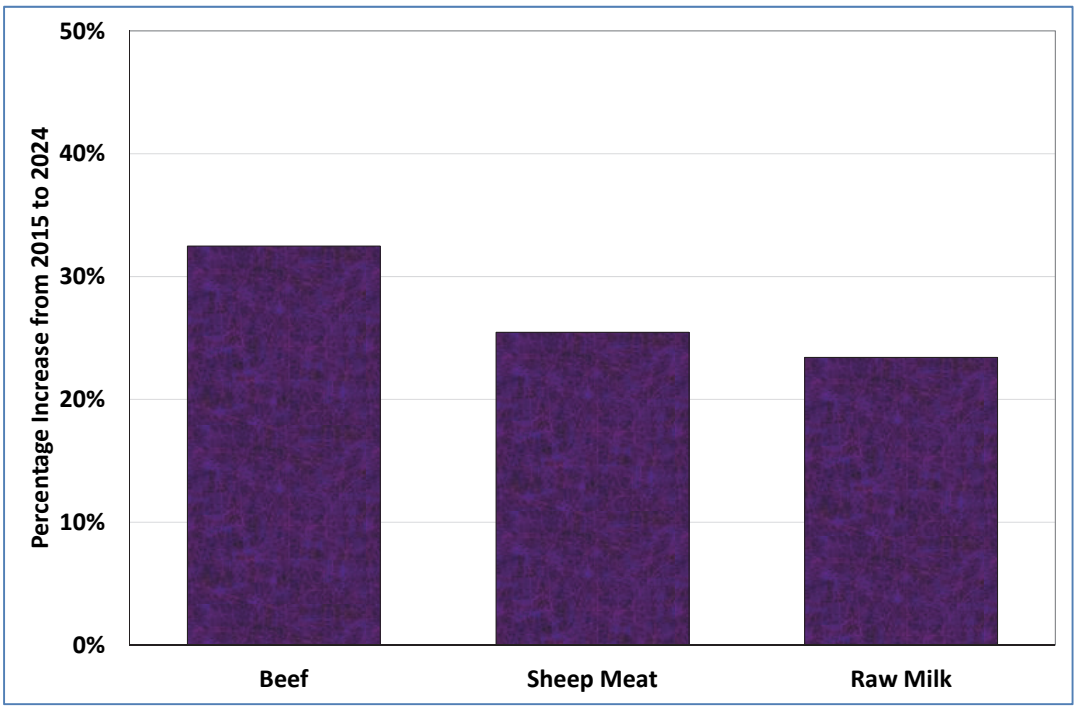


Source: Lincoln Trade and Environment Model.

Figure 5-2 depicts the modelled percentage increases in producer returns in the base scenario. The returns to beef producers are one-third higher in 2024 than in 2015 under these projections, while the returns to sheep meat producers and raw milk producers are around

one-quarter higher. For the dairy producers (which is a much larger sector than beef or sheep meat production), this represents an increase in aggregate returns valued at US$2.4 billion.

Figure 5-2: Growth in New Zealand Meat and Dairy Producer Returns, Future 1, 2015 to 2024



Source: Lincoln Trade and Environment Model.

5.3 Greater Trade Liberalisation in Agri-food Products (Future 2)

One of the factors which has a large negative impact on New Zealand is restricted trade access. Therefore, modelling the impact of greater market access is important. Ideally the modelling could reflect various negotiations under way, including the Trans-Pacific Partnership (TPP) and the EU-NZ free-trade agreement. Given the constraints in this study, the research team analysed the impact of four generic and universal reductions to current trade barriers involving respectively 25%, 50%, 75% and 100% percentage decreases in total tariffs, duties, and market support for all modelled agricultural commodities in all countries of the Lincoln Trade and Environment Model. Thus the results do not aim to reflect the outcomes of any particular trade negotiations, but do show the commodities most affected from trade restrictions. The results from these four scenarios are shown on the following two pages.

Table 5-5 shows the total value of net trade in New Zealand for the final year (2024) of the modelled scenarios under Future 2, alongside the 'base' scenario. This shows that trade liberalisation has the potential to significantly increase the net trade value for all examined commodities, increasing as trade barriers are further relaxed. Promisingly, total dairy net trade for New Zealand increases US$3.6 billion under 100 per cent reductions in barriers.

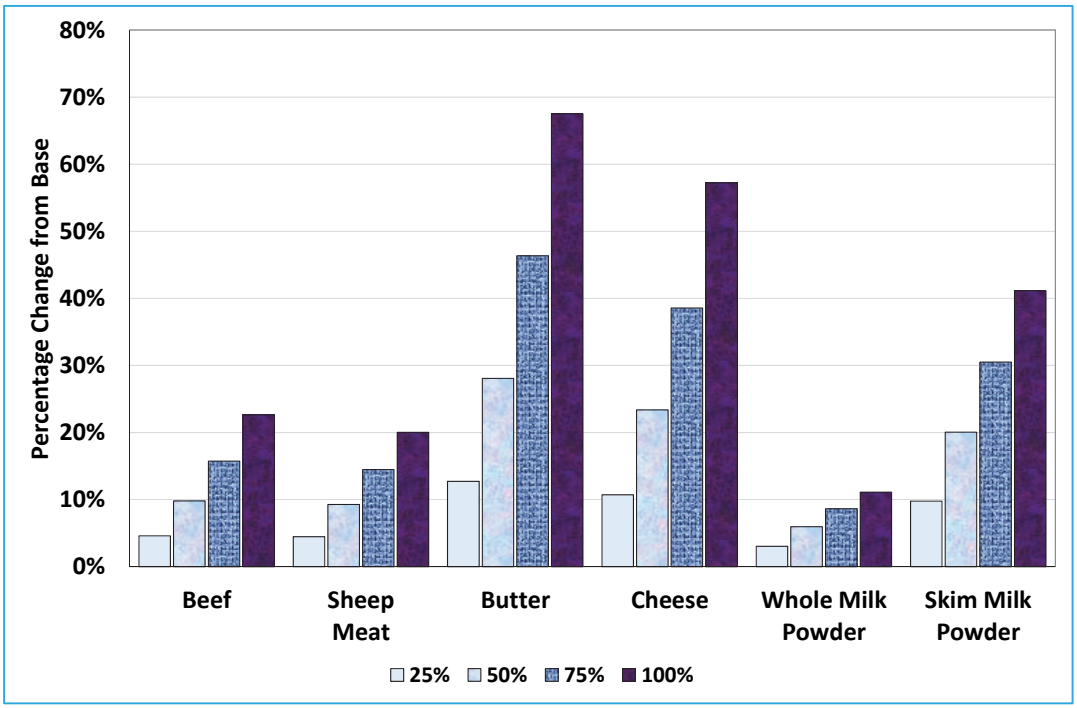
Table 5-5: New Zealand Net Trade Value of Selected Exports, Future 2, 2024

Value in 2024, measured in millions of US dollars	Base Scenario	Reduction in Tariffs			
		25%	50%	75%	100%
Beef	1,654	1,730	1,816	1,914	2,028
Sheep Meat	1,659	1,733	1,813	1,899	1,991
Butter	2,281	2,571	2,921	3,338	3,821
Cheese	1,421	1,573	1,753	1,969	2,234
Whole Milk Powder	5,456	5,622	5,780	5,927	6,061
Skim Milk Powder	1,636	1,796	1,964	2,135	2,309
Total Dairy	10,795	11,563	12,417	13,369	14,425
All Selected Products	14,108	15,026	16,048	17,182	18,444

Source: Lincoln Trade and Environment Model.

Figure 5-3 presents the same results in terms of the percentage increase above the base scenario in 2024. These results suggest that cheese and butter would benefit most from full liberalisation, with the net trade value increasing by 68 and 57 per cent respectively. Beef and sheep meat increase by about 20 per cent each.

Figure 5-3: Percentage Change in Net Trade Value of Selected Exports, 2024, Future 2 Compared to Base



Source: Lincoln Trade and Environment Model.

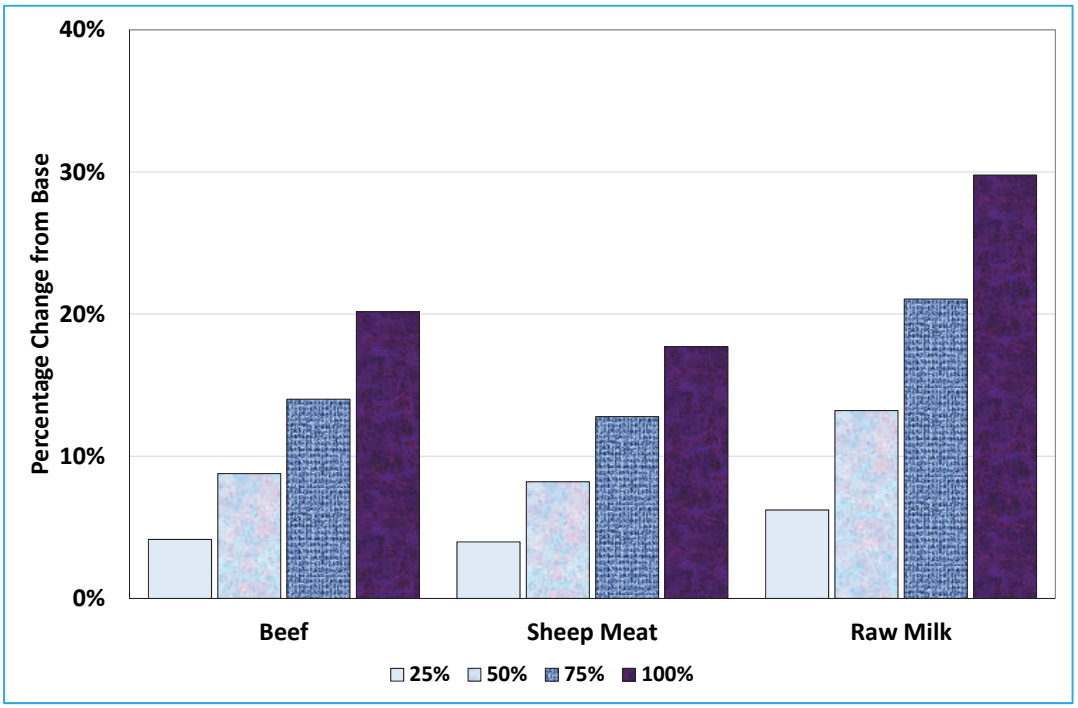
Furthermore the relaxed trade barriers would increase producer returns in New Zealand, shown here in Table 5-6, and Figure 5-4. Reflecting the increases in export value, producer returns are expected to rise given increasing levels of trade liberalisation. The returns for dairy increase 30 per cent given full trade liberalisation, while beef returns increase 20 per cent and sheep meat by 18 per cent.

Table 5-6: Meat and Dairy Producer Returns, Base and Future 2, 2024

Value in 2024, measured in millions of US dollars	Base Scenario	Reduction in Tariffs			
		25%	50%	75%	100%
Beef	2,098	2,185	2,282	2,392	2,521
Sheep Meat	1,987	2,066	2,150	2,241	2,339
Raw Milk	12,642	13,429	14,313	15,304	16,408

Source: Lincoln Trade and Environment Model.

Figure 5-4: Percentage Change in Meat and Dairy Producer Returns, 2024, Future 2 Compared to Base



Source: Lincoln Trade and Environment Model.

5.4 Market Segmentation and Consumer Targeting (Future 3)

In Future 3, two scenarios were developed in order to estimate the potential impact of varying levels of premiums for food attributes in selected countries as a result of market segmentation and consumer targeting. In scenarios 3.1 and 3.2, it is assumed that New Zealand achieves a premium of 20 per cent and 50 per cent respectively in seven developed countries: Australia, Canada, Europe Union (28), Korea, Japan, and the United States of America, and three developing countries: China, India, and Indonesia.

The value of a 20 per cent premium was based on advice that the most recent New Zealand Primary Sector Bootcamp at Stanford University (28 June to 4 July 2015) had considered that a 20 per cent premium for New Zealand agri-food exports on the basis of the credence attributes of New Zealand production and processing systems is a reasonable aspirational target. The higher value of 50 per cent was chosen to explore the impact if New Zealand achieves outstanding success in this approach.

The following pages report the results of each of the scenarios alongside the base.

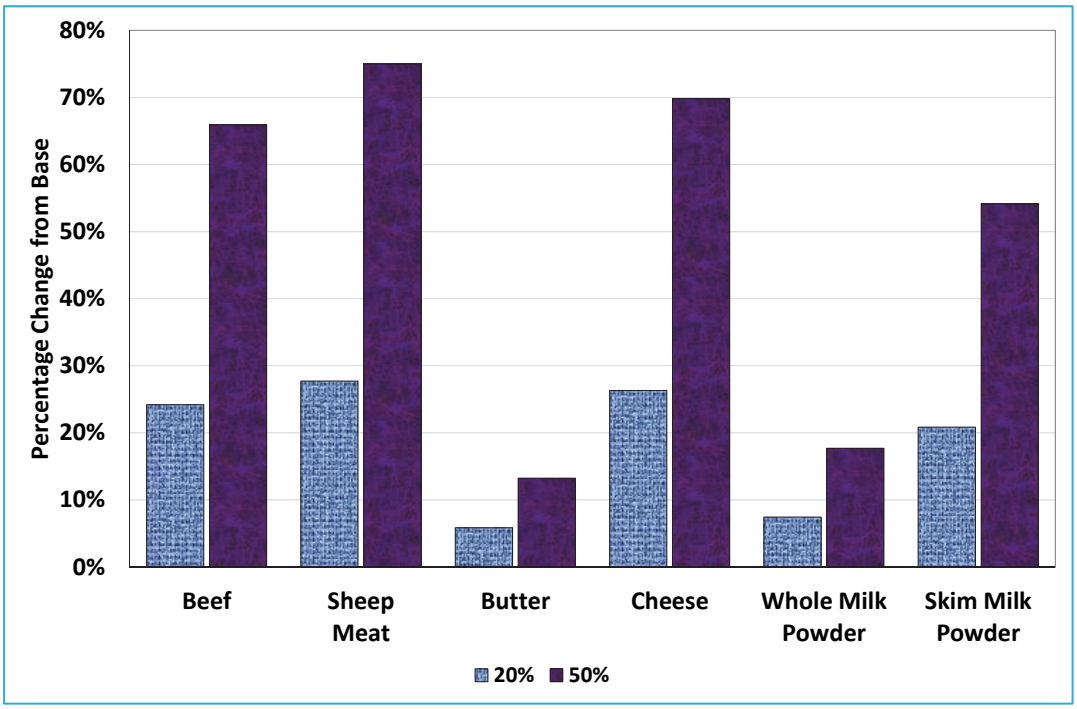
The inclusions of price premiums show a growth in the total net trade value for all commodities, as shown in Table 5-7 and Figure 5-5. The increase for all selected products is about US$2.1 billion in the first scenario and about US$5.5 billion in the second scenario. A 20 per cent premium could raise the value net trade for beef, sheep meat, and cheese by about one-quarter. Furthermore a 50 per cent premium would raise this increase to around 70 per cent for each of these three products.

Table 5-7: New Zealand Net Trade Value of Selected Exports, Future 3, 2024

Value in 2024, measured in millions of US dollars	Base Scenario	Price Premium Achieved	
		20%	50%
Beef	1,654	2,054	2,744
Sheep Meat	1,659	2,119	2,903
Butter	2,281	2,414	2,583
Cheese	1,421	1,795	2,413
Whole Milk Powder	5,456	5,862	6,422
Skim Milk Powder	1,636	1,977	2,522
Total Dairy	10,795	12,049	13,939
All Selected Products	14,108	16,222	19,587

Source: Lincoln Trade and Environment Model.

Figure 5-5: Percentage Change in Net Trade Value of Selected Exports, 2024, Future 3 Compared to Base



Source: Lincoln Trade and Environment Model.

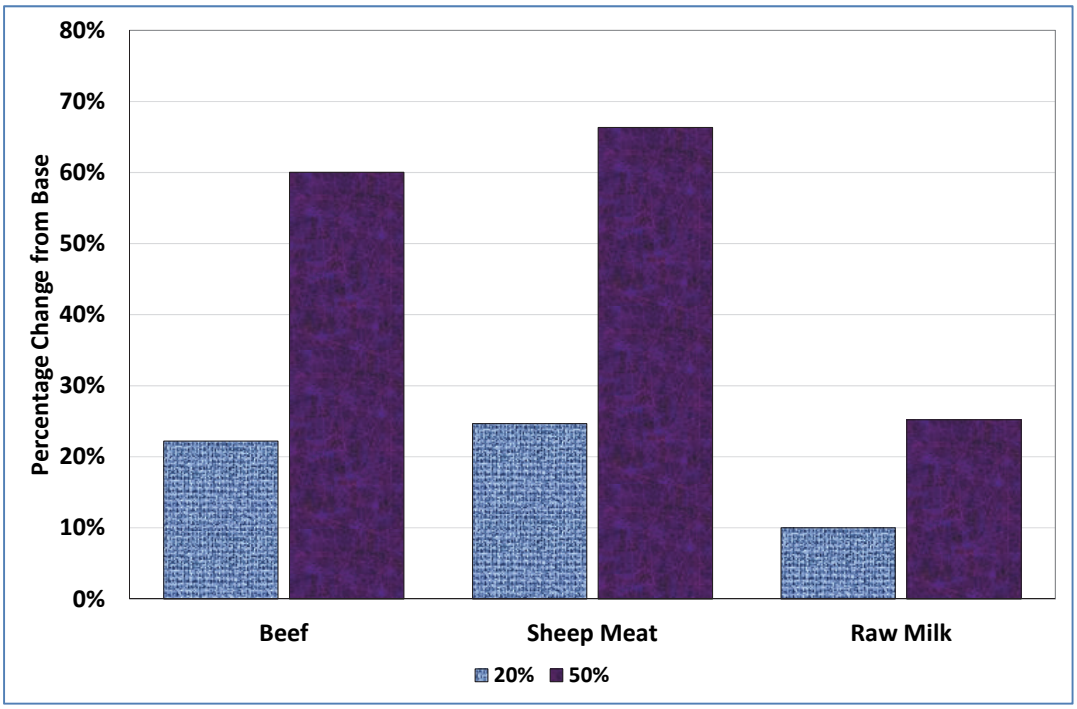
Table 5-8 and Figure 5-6 show the modelled increases in producer returns, which are significantly higher than in Future 2 (note that the vertical axis of Figure 5-6 is twice the height of the vertical axis of Figure 5-4).

Table 5-8: Meat and Dairy Producer Returns, Base and Future 3, 2024

Value in 2024, measured in millions of US dollars	Base Scenario	Price Premium Achieved	
		20%	50%
Beef	2,098	2,564	3,358
Sheep Meat	1,987	2,477	3,305
Raw Milk	12,642	13,907	15,830

Source: Lincoln Trade and Environment Model.

Figure 5-6: Percentage Change in Meat and Dairy Producer Returns, 2024, Future 3 Compared to Base



Source: Lincoln Trade and Environment Model.

5.5 Greater Trade Liberalisation in Agri-food Products alongside Market Segmentation and Consumer Targeting (Future 4)

The fourth future combines the outcomes of Future 2 and Future 3, achieving varying levels of premiums for food attributes and full trade liberalisation for agricultural commodities. Future 4 assumes a 100 per cent reduction in trade barriers from Future 2 and the levels of price premiums are taken from Future 3 (20 and 50 per cent). These scenarios aim to show the potential efficacy of a combined, rather than singular, approach for the future of New Zealand agriculture.

Table 5-9 and Figure 5-7 illustrate the large increases from the base scenario. Complete trade liberalisation plus a 20 per cent price premium results in an almost 50 per cent increase for total dairy, a US$5.3 billion shift. This increases to US$7.8 billion with a 50 per cent premium. Trade in beef and sheep meat is modelled to rise above the base scenario by more than 50 per cent and 100 per cent respectively with a 20 and 50 per cent premium.

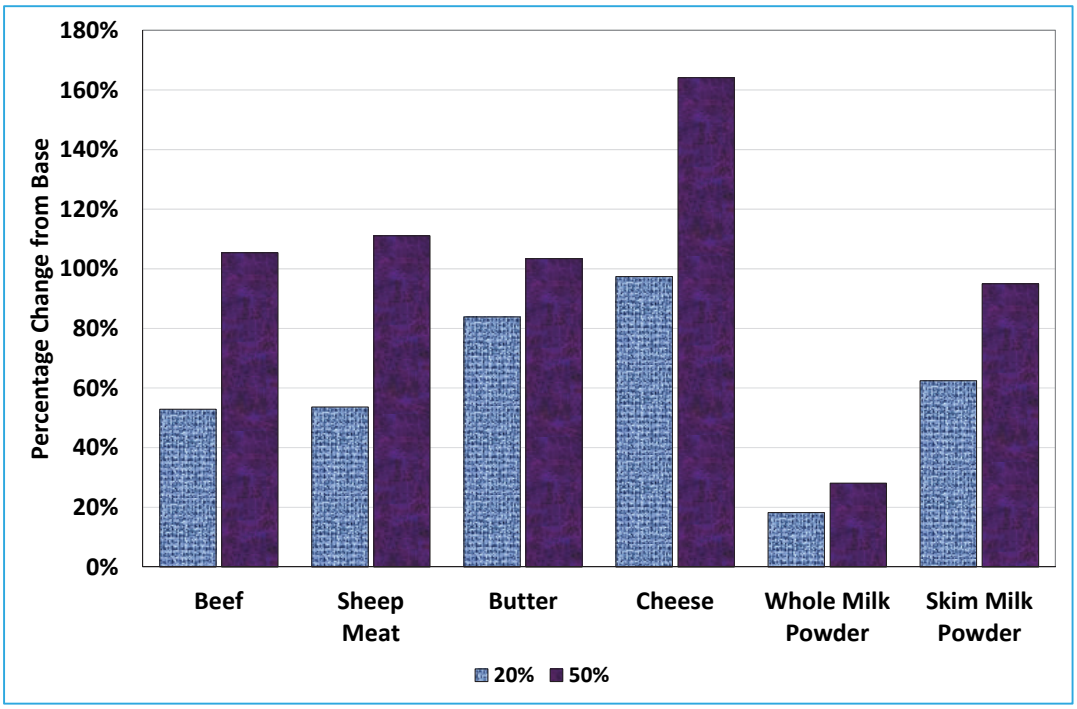
Table 5-10 and Figure 5-8 show the modelled increases in producer returns almost double for beef and sheep meat producers under the second of the two scenarios, while the returns to dairy producers increases by almost two-thirds (worth approximately US$8 billion).

Table 5-9: New Zealand Net Trade Value of Selected Exports, Future 4, 2024

Value in 2024, measured in millions of US dollars	Base Scenario	Price Premium Achieved	
		20%	50%
Beef	1,654	2,529	3,397
Sheep Meat	1,659	2,549	3,502
Butter	2,281	4,194	4,639
Cheese	1,421	2,805	3,753
Whole Milk Powder	5,456	6,451	6,988
Skim Milk Powder	1,636	2,657	3,190
Total Dairy	10,795	16,107	18,570
All Selected Products	14,108	21,185	25,469

Source: Lincoln Trade and Environment Model.

Figure 5-7: Percentage Change in Net Trade Value of Selected Exports, 2024, Future 4 Compared to Base



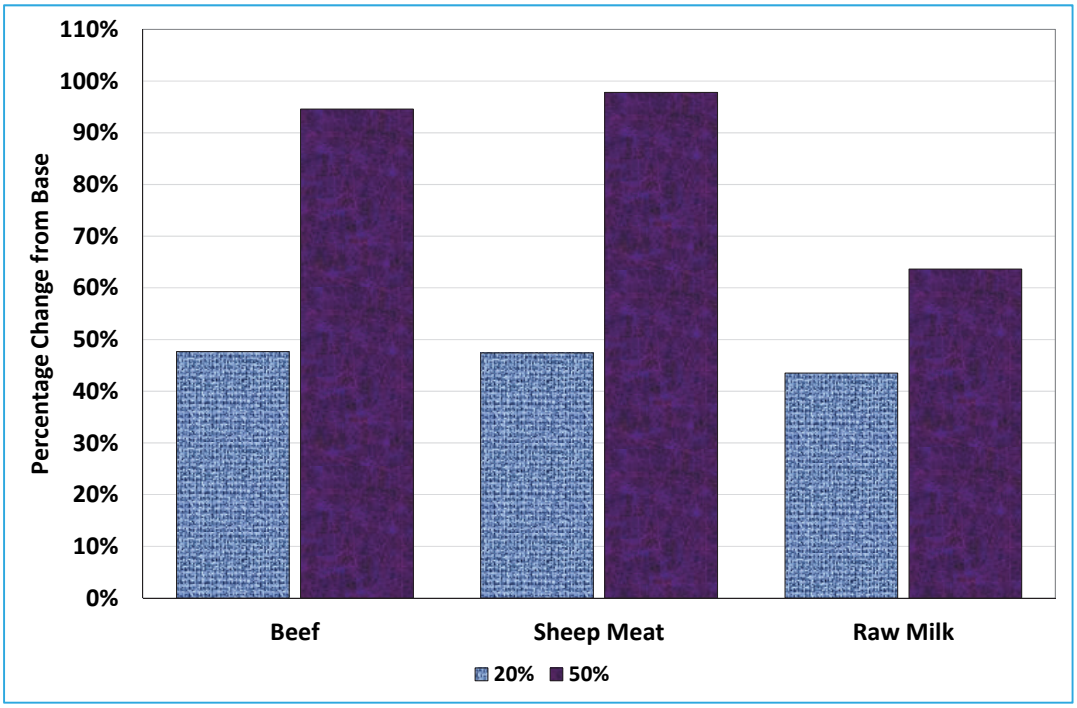
Source: Lincoln Trade and Environment Model.

Table 5-10: Meat and Dairy Producer Returns, Base and Future 4, 2024

Value in 2024, measured in millions of US dollars	Base Scenario	Price Premium Achieved	
		20%	50%
Beef	2,098	3,098	4,082
Sheep Meat	1,987	2,929	3,931
Raw Milk	12,642	18,144	20,684

Source: Lincoln Trade and Environment Model.

Figure 5-8: Percentage Change in Meat and Dairy Producer Returns, 2024, Future 4 Compared to Base

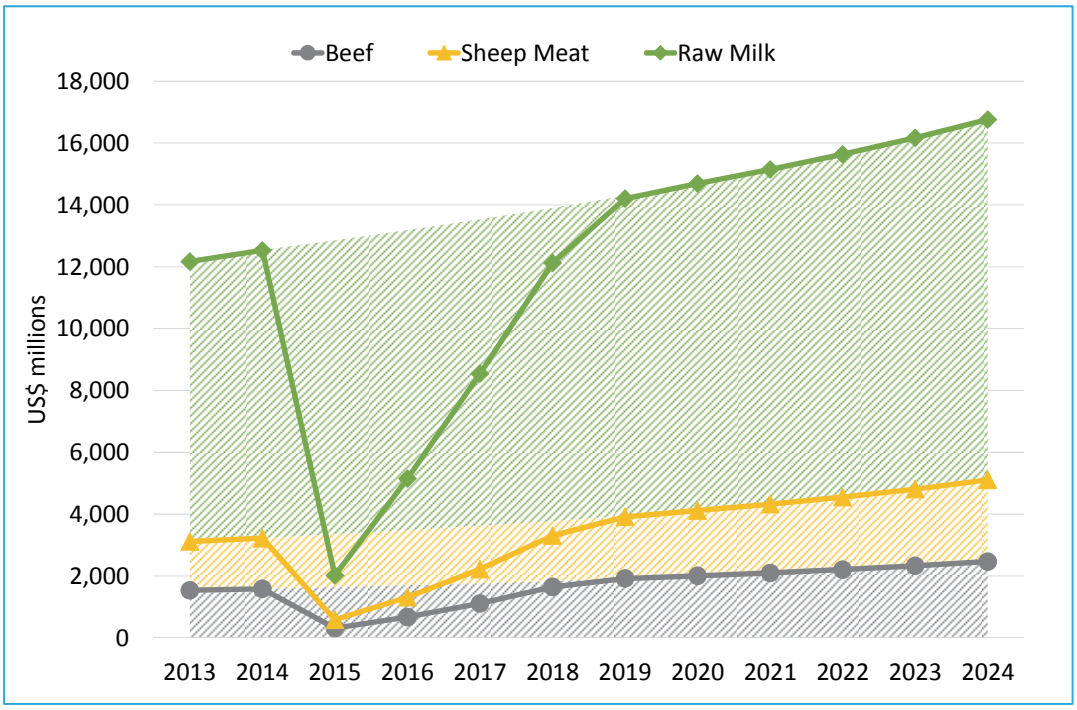


Source: Lincoln Trade and Environment Model.

5.6 Biosecurity Threats to Agri-food Production (Future 5)

As shown in the previous chapter, as an exporting country dependant on its agricultural trade New Zealand is vulnerable to biosecurity risks such as foot-and-mouth disease. In Future 5, two scenarios are used to simulate the effects of an outbreak of this disease in New Zealand on its producers and exporters. In scenario 5.1, it is assumed that there is no loss of market access as a result of the outbreak, so that the only direct impact is the loss of production. In scenario 5.2, New Zealand loses some market access for a time, which results in additional economic losses. In both scenarios, the economy recovers by the end of the modelling horizon (2024) and so there is no impact to present for that year. Instead, the difference is on the transitional period, depicted in the following two figures and tables.

Figure 5-9: Producer Returns after a Foot-and-mouth Outbreak with Limited Loss of Market Access, 2013-2024



Note: Shaded areas represent the base case; the lines represent scenario 5.1.

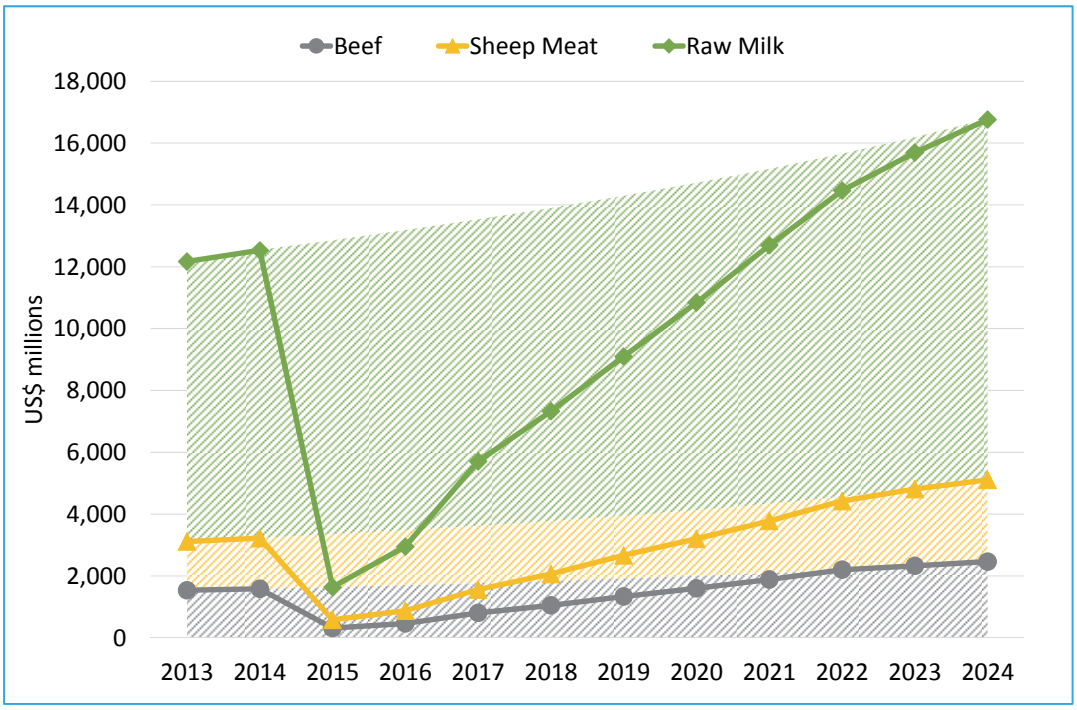
Source: Lincoln Trade and Environment Model.

Table 5-11: Losses in Producer Returns after a Foot-and-Mouth Outbreak with Limited Loss of Market Access (US$ millions), 2015-2024

Year	Beef	Sheep Meat	Raw Milk	Total
2015	1,329	1,439	8,072	10,841
2016	1,033	1,134	5,870	8,037
2017	657	749	3,585	4,991
2018	193	279	1,309	1,781
2019	-1	36	59	94
2020	0	12	13	24
2021	0	10	8	18
2022	0	11	8	19
2023	0	12	9	21
2024	0	14	9	23
Total	**3,211**	**3,696**	**18,943**	**25,850**

Source: Lincoln Trade and Environment Model.

Figure 5-10: Producer Returns after a Foot-and-mouth Outbreak with Loss of Market Access, 2013-2024



Note: Shaded areas represent the base case; the lines represent scenario 5.2.

Source: Lincoln Trade and Environment Model.

Table 5-12: Losses in Producer Returns after a Foot-and-Mouth Outbreak with Loss of Market Access (US$ millions), 2015-2024

Year	Beef	Sheep Meat	Raw Milk	Total
2015	1,329	1,439	8,450	11,219
2016	1,240	1,367	7,626	10,232
2017	964	1,098	5,766	7,829
2018	792	921	4,862	6,575
2019	581	695	3,921	5,197
2020	405	524	2,942	3,871
2021	213	339	1,921	2,473
2022	3	137	1,053	1,194
2023	0	11	484	494
2024	0	14	10	23
Total	**5,527**	**6,546**	**37,035**	**49,107**

Source: Lincoln Trade and Environment Model.

The results are as expected. There are substantial costs as a result of a major outbreak of this disease, which are intensified depending upon the trade sanctions against New Zealand exports from US$25 billion in total to US$49 billion. This confirms official views of the importance of being prepared for any symptoms of a foot-and-mouth outbreak (Combined Government and Industries FMD Preparedness Working Group, 2011).

5.7 Conclusion

The analysis of this chapter confirms some long-standing policy positions in New Zealand; most notably, the importance of liberalising world trade in agri-food products and the importance of biosecurity to protect New Zealand producer returns. The most important result, however, is the potential for significant gains if New Zealand can capture greater premiums for its exported goods through market segmentation and consumer targeting, especially when coupled with further liberalisation of world trade.

6. Conclusion: The Land and the Brand

6.1 Summary of the Report

The opening chapter explained that the AERU at Lincoln University was commissioned to prepare this report assessing the contributions that the agri-food sector has made to the wellbeing of New Zealanders over the decades and in the present day. Our task was to explore the underlying reasons for New Zealand's demonstrated success in its agri-food industries and to analyse current trends affecting the sector, including potential changes in the country's international trading opportunities and possible implications of environmental impacts of production. This has been done in the preceding chapters.

The starting point is the recognition that the agri-food sector continues to dominate the country's merchandise exports despite public policies after 1984 that have aimed to encourage other aspects of the economy (see Figure 1-1). The dairy sector in 2013/14 generated export revenue of just over $18 billion, followed by meat and wool (more than $8 billion), forestry (more than $5.1 billion), horticulture (nearly $3.8 billion) and seafood (more than $1.7 billion).

The agri-food sector makes substantial direct and indirect contributions to the level of economic activity within New Zealand (see Figure 2-7). In 2011/12, agri-food *primary production* accounted directly for $13 billion of value added in the national economy and agri-food *processing* accounted directly for another $12 billion. The combined total of $25 billion represented 12 per cent of gross domestic product. The indirect contributions through purchases of inputs from other parts of the economy in 2011/12 amounted to another $15 billion, bringing the total share of the national economy to 19 per cent.

Thus, for every $5 of value created in the economy each year, just under $1 is due directly or indirectly to the agri-food industries.

Data from the 2013 Census recorded just under 10,000 people employed in the agri-food primary and processing industries. This workforce has a lower level of qualifications than the general workforce (see Table 2-7), suggesting there may be further opportunities for skill-based increases in labour productivity throughout the sector. Chapter 2 also discussed potential for greater contributions from the sector towards the country's social and environmental objectives.

Chapter 3 explained how the history of the country's agri-food production, processing and exporting is replete with examples of New Zealand enterprise creating and capturing value through the interaction of four key elements: changes in international trade; developments in domestic industries and policies; innovations in science and technology; and creations of trusted commercial brands. The chapter focused on five key events:

1. The early human migrations from the 13th to the 19th century
2. The first shipment of refrigerated meat to the United Kingdom in 1882
3. The Ottawa Agreement, signed in 1932
4. The end of bulk purchase agreements with the United Kingdom in 1954
5. The beginning of New Zealand's decade of economic reforms in 1984

The discussion documented the adaption of overseas technologies by the first Māori and European settlers, the shift in exports from wool to meat and dairy following refrigeration, the introduction of the statutory marketing boards between 1922 and 1977, the initial reliance on exports to the United Kingdom followed by greater diversification from the middle of the twentieth century, and the impact of domestic economic reform after 1984.

The international trading environment continues to change. Chapter 4 presented four trends in global markets currently affecting New Zealand producers and processors: (1) growth in global agricultural production; (2) increased market segmentation and consumer targeting; (3) greater trade liberalisation in agri-food products; and (4) biosecurity threats to agri-food production. These developments are leading to changes in consumption, production and trade patterns in New Zealand and elsewhere. They therefore present potential opportunities but also challenges for New Zealand's land based sectors.

To evaluate the opportunities, the Lincoln Trade and Environment Model (LTEM) was used to analyse possible Futures developed in consultation with the project's advisory board. The period of analysis was for the decade 2015 to 2024. Even on base projections drawn from official international data sources (Future 1), the analysis indicated increases in New Zealand net exports of beef, sheep meat, butter, cheese, whole milk powder and skim milk powder (see Figure 5-1), suggesting growth in producer returns of about one-third (for beef producers) or one-quarter (for sheep meat producers and raw milk producers).

Future 2 analysed the impact of reductions in total tariffs, duties, and market support for all modelled agricultural commodities in all countries of LTEM. A range of reductions was addressed, from 25 to 100 per cent. This showed that trade liberalisation has the potential to significantly increase the net trade value for all the examined commodities, increasing the more trade barriers are relaxed. Compared to the base scenario, for example, total dairy net trade for New Zealand increased by US$3.6 billion with 100 per cent reductions in barriers.

Future 3 is based on the well-established observation that market segmentation and consumer targeting can deliver greater value to final purchasers, generating a price premium throughout a value chain. Based on this observation, Future 3 analysed the impacts of two scenarios if New Zealand achieved a premium of 20 per cent or 50 per cent respectively in seven developed countries (Australia, Canada, Europe Union (28), Korea, Japan, and the United States of America) and three developing countries (China, India, and Indonesia). The increase in net trade beyond that achieved in the base scenario for all selected products was about US$2.1 billion in the first scenario and about US$5.5 billion in the second scenario. Even in the first scenario, the modelled increase in returns to beef and sheep meat producers was more than 20 per cent and was 10 per cent for raw milk producers.

Future 4 combined Future 2 (assuming 100 per cent reductions in trade barriers) and Future 3 (assuming price premiums of 20 per cent and 50 per cent in two different scenarios). This produced the biggest increases in net trade and returns. Complete trade liberalisation plus a 20 per cent price premium resulted in an almost 50 per cent increase for total dairy net trade, a US$5.3 billion shift beyond the base scenario. This increased to US$7.8 billion with a 50 per cent premium. Trade in beef and sheep meat was modelled to rise above the base scenario by more than 50 per cent and 100 per cent respectively with a 20 and 50 per cent premium. The modelled increases in producer returns almost doubled for beef and sheep meat producers under the second of the two scenarios, while the returns to dairy producers increased by almost two-thirds (worth approximately US$8 billion per annum).

Finally, Future 5 considered biosecurity threats to agri-food production in New Zealand, paying particular attention to the impact of an outbreak of foot and mouth disease under two scenarios. In both scenarios, there was a loss of production while the outbreak is controlled. The first scenario assumed only a limited loss of access to international markets as a consequence of the outbreak; in the second scenario the market reaction was assumed to be strongly negative with market access taking a decade to be restored. In both scenarios there were substantial costs as a result of a major outbreak of the disease. In the first scenario, the loss was US$25 billion; this increased to nearly US$50 billion in the second scenario as a result of enduring trade sanctions against New Zealand exports.

6.2 A Vision for Future Growth

These results suggest that the agri-food sector will continue to play a dominant role in the New Zealand economy over the next decade if it succeeds in maximising value creation through integrating domestic industry developments, science and technology innovation and trusted commercial brand creation in the new international trading environment. The authors suggest six aspects that we argue would facilitate the sector's continued growth:

- the importance of industry leadership;
- private-public partnerships;
- effective science and innovation systems;
- market awareness,
- responsive skills development ecosystems; and
- cooperative investment to support value chain enhancements.

These can be explained briefly as follows. The importance of industry leadership comes from the key role that consumer targeting plays in capturing increased value for New Zealand produce; industry know their customers best and are therefore best placed to initiate efforts for providing value that can attract a premium for quality.

Nevertheless, there are aspects of value creation and value communication that can be achieved only through private-public partnerships. The ongoing roles of the government in biosecurity and negotiating greater trade liberalisation are obvious examples, but there are also public good characteristics in each of the following three components.

Science and innovation have always been at the foundation of developments in New Zealand agri-food production and processing. If New Zealand is to capture value on the basis of the credence attributes of its production and processing systems, then good science will be required, in the words of the mission for *Our Land and Water* national science challenge: "to enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations".

Markets are increasingly sophisticated and differentiated. Moreover, New Zealand is targeting a wider range of growing markets than previously in its history. To capture and maintain value in these markets, New Zealand exporters have to be aware of what attributes consumers value and are willing to pay for, and how these attributes can be communicated. New Zealand's food production has many positive qualities associated with it and these must be communicated into markets, including through a strong New Zealand brand.

This vision of the sector's development entails a move away from New Zealand being known as a low-cost provider of agri-food commodities to New Zealand being known as a high value provider of agri-food products. This in turn will require an increase in the skills of the sector's labour force, which chapter 2 noted is below that of the rest of the economy (see Figure 2-15 and Table 2-7). Responsive skills development systems have the aim of ensuring educators and employers are communicating with each other to ensure that qualifications represent authentic skills demanded by industry.

Finally, the vision requires collaborative value chains in which the expectations of consumers are effectively communicated to producers and the credential attributes of production systems are effectively communicated to consumers. The sustenance of collaborative value chains is not easy (see, for example, Value Chain Management Centre, 2012), but the reward will be an ability to capture the full value of New Zealand's land and brand.

6.3 Required Future Research

This report began by criticising the suggestion by Hendy and Callaghan (2013, pp. 15-16) among others that there might be a contrast between primary sector growth and investing in science and technology. Previous chapters have documented how science-driven innovation has always been an essential part of the New Zealand agri-food sector. This will continue into the future, with a stronger focus on commerce-based research to supplement the ongoing ecological and life sciences research in the country's universities and Crown Research Institutes. This report finishes with five examples of this, each drawn from the vision of the previous section, where greater research effort will contribute to further development: the New Zealand story; engagement with citizens; international trade liberalisation; responsive systems for skills development; and capturing value chain opportunities.

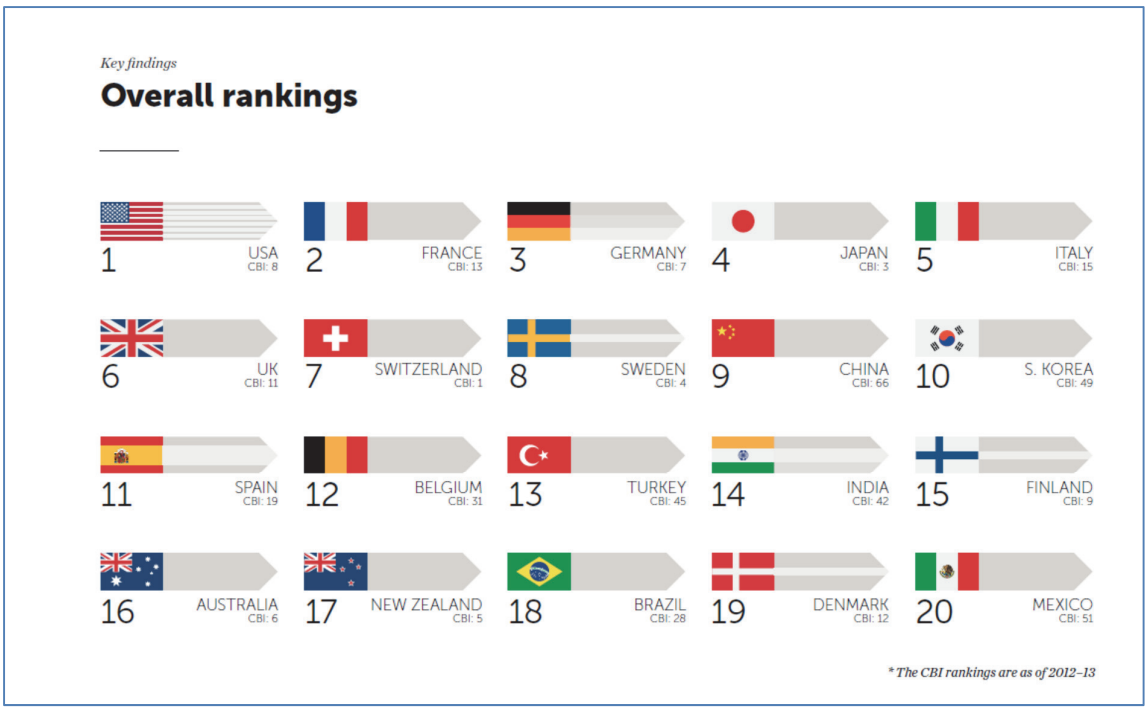
The New Zealand Story

A recent report by a London consultancy on the value of country of origin brands argues that "countries, like companies, are beginning to use branding to help them market themselves for investment, tourism and exports" (FutureBrand 2015, p. 4). It gives the following example directly relevant to the agri-food sector (Ibid, emphasis added):

A very recent manifestation of the importance of these issues – as a result of the 2013 'Horsemeat scandal' – is the introduction of new EU food labelling regulations and the increased emphasis given to Country of Origin labeling. The scandal centered from the revelation that the origin, provenance and 'type' of meat in food products were incorrectly marketed, lacking transparency and misleading consumers. As a result all packaged products must now indicate the country or countries of origin of all production stages. This demonstrates that *origin is more than ever an expression of quality* and is crucial information for the consumer.

The same source provided a ranking of country of origin brands, which placed New Zealand in position 17, just behind Australia. FutureBrand also listed the top ten rankings across industry sectors (idem, p. 17). New Zealand did not feature in any of these rankings and so was absent from the list for food and beverage where the top ten countries in order were France, Italy, Spain, USA, Japan, Germany, United Kingdom, Switzerland, Turkey and Belgium.

Figure 6-1: Overall Rankings of Country of Origin Brands, 2014



Source: FutureBrand (2014, p. 16).

The New Zealand Government has taken steps to strengthen the Made in New Zealand brand through the New Zealand Story business toolkit, described as "an initiative that defines the distinctly Kiwi attributes that make us unique and provides a framework to help us better communicate our value to the world" (see www.nzstory.govt.nz/what-is-nz-story). The story is based on three themes (Open Spaces, Open Hearts, Open Minds) and three core values (kaitiaki, integrity and resourcefulness).

Within that overarching framework, further research is required directed at developing the New Zealand brand as a *country of origin for quality food and beverages*. Such research will need to be consumer focused but industry led. This means ongoing research in key domestic and international markets to understand how consumers understand and value quality in their food and beverage purchases (Dalziel and Saunders, 2016; Guenther *et al*, 2015). It will also require research among New Zealand producers and processors to understand and strengthen the country's quality assurance systems and how these can be communicated to consumers.

Engagement with Citizens

At the Mystery Creek National Fieldays in 2015, the President of Federated Farmers of New Zealand, Dr William Rolleston, gave an address on the challenge of maintaining the social licence to farm in New Zealand. Rolleston described the concept of a social licence to operate as "the complex mix of philanthropic, ethical, legal and economic expectations that a community and stakeholders may have which enables an operation, in this case farming, to continue in a local community". He described challenges created by the continued urbanisation of New Zealand and by the continued development and intensification of agriculture itself. He warned of the dangers of allowing interest groups to claim to represent the public to promote a particular point of view and advocated instead that the sector "must meet the challenge through engagement, understanding, honesty and clarity with the backing of sound evidence".

Sound evidence comes from independent and quality research. There should be an annual survey of New Zealand citizens by an independent research organisation that documents changes over time in domestic perceptions of the issues facing farmers and other agri-food producers. The results from the survey would help inform industry and policy officials about hot spots requiring attention or widespread misunderstanding needing to be addressed with accurate information. This should be part of the New Zealand story, reflecting its three core values of kaitiaki, integrity and resourcefulness.

International Trade Liberalisation

Chapter 5 of this report has demonstrated how trade modelling can be used to identify and measure opportunities for increasing New Zealand producer returns through international trade liberalisation. For the purposes of this report, the modelling was at a very high level. To aid New Zealand negotiators, and to help communicate the benefits of free trade agreements to the general public, more detailed analysis should be undertaking on specific policy options, such as modelling the impact of successful completion of a free trade agreement with the European Union, or with India, and the impact of the free trade components of the Trans-Pacific Partnership (TPP).

Chapter 5 identified the major threat to market access if New Zealand experienced a serious outbreak of foot and mouth disease. Analysis of this type should be extended to other potential biosecurity incursions such as fruit fly or Californian thistle. The analysis would contribute to understanding the benefits of spending resources on biosecurity in order to reduce the risks of losing key markets through an incursion.

Responsive Systems for Skills Development

It was noted earlier in this chapter that the workforce in the agri-food primary and processing industries has a lower level of qualifications than the general workforce (see also Table 2-7). This indicates opportunities for skill-based increases in labour productivity throughout the sector. For such a strategy to be effective, it is essential that providers of *qualifications* ensure that their graduates have *relevant skills* demanded by industry.

Creating and sustaining systems for effective matching of qualifications and relevant skills requires ongoing research among employers and educators to ensure that skills development is responsive to changing technologies and opportunities in industry (see, for example, Dalziel, 2015). This goes well beyond industry training within specific sectors; it is also important for the design of career pathways for researchers and scientists creating new knowledge in agri-food systems, as well as for the design of degrees offered by the country's business schools.

Capturing Value Chain Opportunities

One of the insights of the brand literature is that successful *product* brands identified with a particular country contribute to strengthening the wider *country of origin* brand (FutureBrand, 2014, p. 14). Thus there are benefits for the whole sector if particular iconic brands achieve a greater profile for success. Business research in two dimensions is required to capture these benefits.

First, research is required to identify and communicate the most successful examples of New Zealand led value chains, as exemplified more than a decade ago by Campbell-Hunt *et al*. (2001). Such research contributes to the profile of the successful value chain, while providing exemplary case studies from which other enterprises can learn. A value chain is often a narrower concept that a particular industry or even a particular enterprise. The modelling in this report, for example, has concentrated on beef, sheep meat and dairy products, but firms create and capture value through a wide range of differentiation within these categories. To illustrate, ANZCO foods currently promotes 13 major brands for its beef and lamb products: Angel Bay; Aria Farm; Butchers Hook; Canterbury Angus; Canterbury Lamb; Greenstone Creek; Kumanu Lamb; Longdown Lamb; Maori Lakes Lamb; Māori Lakes Beef; Ocean Beef; Riverlands; and Wakanui (www.anzcofoods.com/our-products).

Second, detailed research is required on specific global value chains to identify opportunities for creating, communicating and capturing greater value from New Zealand's agri-food products. The importance of this is reflected in the recent report on *Characterizing the Determinants of Successful Value Chains* prepared for the Canadian Agri-Food Policy Institute, for example, which offers a realistic assessment of the benefits and difficulties of creating "collaborative" global value chains (Value Chain Management Centre, 2012, p. 9):

> Successfully adopting this type of model requires the involved businesses to possess compatible cultures, vision, and leadership. It also requires an external environment that is conducive to supporting and enabling such an approach. While the model can undoubtedly produce greater rewards than the three alternative models, it also generates increased risks, particularly for businesses that are still developing (as opposed to refining) their value chain management skills.

6.4 Conclusion

The title of this report is *The Land and the Brand*, which expresses the core theme of its contents: In globalised markets, commercial success requires a combination of quality production systems ("*The Land*") and quality consumer perceptions ("*The Brand*").

This is true for individual products, for particular enterprises, for specific value chains, for different sectors, and indeed for New Zealand as a high profile country-of-origin for quality food and beverages. Internationally, New Zealand has some strong competitive advantages in its land and in its brands, but the report offers a vision for how research and development will improve both aspects of this combination to create new opportunities for New Zealand agri-food exporters.

Consistent with that vision, the New Zealand agri-food sector will continue to be at the heart of science-led development of the country's national and regional economies.

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Appendix 1: Defining the Agri-Food Sector

As explained in Chapter 1, different data sources define the agri-food sector or its equivalent in different ways. The data series in Figure 1-1 is based on the *New Zealand Harmonised System Classification 2012* (see Statistics New Zealand, 2011). This groups products into 21 sections and 97 chapters. The chapters selected for the agri-food sector are the following:

Section I – Live animals; animal products

- 01 Animals; live
- 02 Meat and edible meat offal
- 03 Fish and crustaceans, molluscs and other aquatic invertebrates
- 04 Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included
- 05 Animal originated products; not elsewhere specified or included

Section II – Vegetable products

- 06 Trees and other plants, live; bulbs, roots and the like; cut flowers and ornamental foliage
- 07 Vegetables and certain roots and tubers; edible
- 08 Fruit and nuts, edible; peel of citrus fruit or melons
- 09 Coffee, tea, mate and spices
- 10 Cereals
- 11 Products of the milling industry; malt, starches, inulin, wheat gluten
- 12 Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit, industrial or medicinal plants; straw and fodder
- 13 Lac; gums, resins and other vegetable saps and extracts
- 14 Vegetable plaiting materials; vegetable products not elsewhere specified or included

Section III – Animal or vegetable fats and oils and their cleavage products; prepared animal fats; animal or vegetable waxes

- 15 Animal or vegetable fats and oils and their cleavage products; prepared animal fats; animal or vegetable waxes

Section IV – Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes

- 16 Meat, fish or crustaceans, molluscs or other aquatic invertebrates; preparations thereof
- 17 Sugars and sugar confectionery
- 18 Cocoa and cocoa preparations
- 19 Preparations of cereals, flour, starch or milk; pastrycooks' products
- 20 Preparations of vegetables, fruit, nuts or other parts of plants
- 21 Miscellaneous edible preparations
- 22 Beverages, spirits and vinegar

23 Food industries, residues and wastes thereof; prepared animal fodder
24 Tobacco and manufactured tobacco substitutes

Section VIII – Raw hides and skins, leather, furskins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silkworm gut)

41 Raw hides and skins (other than furskins) and leather
42 Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut)
43 Furskins and artificial fur; manufactures thereof
44 Wood and articles of wood; wood charcoal
45 Cork and articles of cork
46 Manufactures of straw, esparto or other plaiting materials; basketware and wickerwork

Section X – Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard; paper and paperboard and articles thereof

47 Pulp of wood or other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard
48 Paper and paperboard; articles of paper pulp, of paper or paperboard

Section XI – Textiles and textile articles

50 Silk
51 Wool, fine or coarse animal hair; horsehair yarn and woven fabric
52 Cotton
53 Vegetable textile fibres; paper yarn and woven fabrics of paper yarn

Note that Chapter 49 is not included in this list ("Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans"). Other chapters in Section XI (e.g. Chapter 57 Carpets and other textile floor coverings) and some chapters in section XI (e.g. Chapter 64, Footwear, gaiters and the like; parts of such articles) might have been included because of their large reliance on animal products, but have not.

These definitions were also used in chapter 2, especially for Table 2-4, Figures 2-11, 2-12 and 2-13.

In chapter 2, section 2.3 includes an analysis of the agri-food industries by occupation. This was based on data requested from Statistics New Zealand, with user-defined industries based on the New Zealand Standard Industry Classification 2006 framework. There were five primary industries and five processing industries defined for this exercise, based on dairy, sheep and beef, horticulture, forestry and seafood. The definitions of these user-defined industries are given in the two tables below, based on 6-digit ANZSIC06 industries.

User Defined Primary Industries	6-Digit ANZSIC06 Industries
Dairy Primary	A016000 Dairy Cattle Farming
Sheep and Beef Primary	A014100 Sheep Farming (Specialised) A014200 Beef Cattle Farming (Specialised) A014300 Beef Cattle Feedlots (Specialised) A014400 Sheep-Beef Cattle Farming A014500 Grain-Sheep and Grain-Beef Cattle Farming A052200 Shearing Services
Horticulture Primary	A011100 Nursery Production (Under Cover) A011200 Nursery Production (Outdoors) A011300 Turf Growing A011400 Floriculture Production (Under Cover) A011500 Floriculture Production (Outdoors) A012100 Mushroom Growing A012200 Vegetable Growing (Under Cover) A012300 Vegetable Growing (Outdoors) A013100 Grape Growing A013200 Kiwifruit Growing A013300 Berry Fruit Growing A013400 Apple and Pear Growing A013500 Stone Fruit Growing A013600 Citrus Fruit Growing A013700 Olive Growing A013900 Other Fruit and Tree Nut Growing
Forestry Primary	A030100 Forestry A030200 Logging A051000 Forestry Support Services
Seafood Primary	A020100 Longline and Rack (Offshore) Aquaculture A020200 Caged (Offshore) Aquaculture A020300 Onshore Aquaculture A041100 Rock Lobster and Crab Potting A041200 Prawn Fishing A041300 Line Fishing A041400 Fish Trawling, Seining and Netting A041900 Other Fishing

User Defined Processing Industries	6-Digit ANZSIC06 Industries
Dairy Processing	C113100 Milk and Cream Processing C113200 Ice Cream Manufacturing C113300 Cheese and Other Dairy Product Manufacturing
Sheep and Beef Processing	C111100 Meat Processing C111300 Cured Meat and Smallgoods Manufacturing C131100 Wool Scouring C131200 Natural Fibre Textile Manufacturing C132000 Leather Tanning, Fur Dressing and Leather Product Manufacturing
Horticulture Processing	C114000 Fruit and Vegetable Processing
Forestry Processing	C121400 Wine and Other Alcoholic Beverage Manufacturing C122000 Cigarette and Tobacco Product Manufacturing C141100 Log Sawmilling C141200 Wood Chipping C141300 Timber Resawing and Dressing C149100 Prefabricated Wooden Building Manufacturing C149200 Wooden Structural Fittings and Components Manufacturing C149300 Veneer and Plywood Manufacturing C149400 Reconstituted Wood Product Manufacturing C149900 Other Wood Product Manufacturing n.e.c. C151000 Pulp, Paper and Paperboard Manufacturing C152100 Corrugated Paperboard and Paperboard Container Manufacturing
Seafood Processing	C112000 Seafood Processing

In chapter 2, section 2.2 analysed the contribution of the agri-food sector to gross domestic product. The selection of industries to define the core agri-food sector was based on the distinctions recognised in chapter 1 between different industries and different levels of processing. This resulted in the definition of seven primary industries and eight processing industries, presented in Table 2.1. This is reproduced below.

Primary Industries	Processing Industries
Horticulture and fruit growing	Meat and meat product manufacturing
Sheep, beef cattle and grain farming	Seafood processing
Dairy cattle farming	Dairy product manufacturing
Poultry, deer and other livestock farming	Fruit, oil, cereal and other food product manufacturing
Forestry and logging	Beverage and tobacco product manufacturing
Fishing and aquaculture	Textile, leather, clothing and footwear manufacturing
Agriculture, forestry and fishing support services and hunting	Wood product manufacturing
	Pulp, paper and converted paper product manufacturing

Appendix 2: Structure of the Lincoln Trade and Environment Model

In the LTEM, global agricultural markets are assumed perfectly competitive. Supply and demand equations are defined as constant elasticity functions that incorporate both the own and cross-price effects. As shown in equation 1 for commodity (i) and country (j) domestic supply is specified as a function of the supply shifter ($ssft_{ij}$), a policy variable (Z) and producer prices of the own (pp_{ij}) and other substitute and complementary commodities (pp_{kj}) (Cagatay and Saunders, 2003; Saunders *et al*, 2004).

$$qs_{ij} = f(ssft_{ij}, Z_j, pp_{ij}, pp_{kj}) \quad (1)$$

Domestic demand (qd_{ij}) is defined as a function of the demand shifter ($dsft_{ij}$), consumer prices of the own (pc_{ij}) and other substitute and complementary commodities (pc_{kj}), and per capita real income (pop_j/GDP_j), see equation 2.

$$qd_{ij} = g(dsft_{ij}, pc_{ij}, pc_{kj}, pop_j/GDP_j) \quad (2)$$

The trade price (pt) of a commodity (i) in a country (j) is determined by the world market price ($WDpt_i$) for that commodity and the exchange rate (ex_j), as shown in 3quation 3. The total effect of world market price on trade price of the country is determined by the price transmission elasticity. Domestic producer (pp_{ij}) and consumer prices (pc_{ij}) are specified as functions of trade price (pt) of a related commodity (i) and commodity specific production and consumption related domestic support/subsidy policies, (Zs_j, Zd_j), which represents the price wedge, see equations 4 and 5 (Cagatay and Saunders, 2003; Saunders *et al*, 2004).

$$pt_{ij} = h(WDpt_i, ex_j) \quad (3)$$

$$pp_{ij} = l(pt_{ij}, Zs_j) \quad (4)$$

$$pc_{ij} = m(pt_{ij}, Zd_j) \quad (5)$$

In the model, stocks ($qst_{ij}^{t=0}$) are determined as the product of stocks from the previous year (qst_{ij}^{t-1}) and the quantity supplied (qs_{ij}) minus the quantity demanded (qd_{ij}) of the commodity (i), as shown in equation 6. Net trade (qt) of a commodity (i) in country (j) is determined as the difference between domestic supply and the sum of domestic demand and stock changes in the related year, see equation 7. The LTEM is a synthetic model since the parameters are taken from the literature (Saunders *et al*, 2004).

$$qst_{ij}^{t=0} = qst_{ij}^{t-1}(qs_{ij} - qd_{ij}) \quad (6)$$

$$qt_{ij} = qs_{ij} - qd_{ij} - \Delta qst_{ij} \quad (7)$$

For dairy trade, raw milk is not traded because it is assumed to be completely used in the production of the other dairy products, and the supply of liquid milk is assumed to be used in domestic consumption. Commodity supply and demand equations are parameterised to reproduce 2008 base data for each country's price, supply, demand and trade. When consumption and production shifts or consumer and producer support wedges are altered, the model recalculates domestic supply and demand and re-balances world trade, production, consumption and prices. Prices and quantities observed in the base period can then be compared to the new values that emerge from the model (Cagatay and Saunders, 2003; Wijegunawardane, 2002).

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