



## New Zealand's food story: The Pukekohe hub Prepared for Horticulture New Zealand

August 2018

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# Glossary

Acronym	Full name
CGE	Computable general equilibrium
DAE-RGEM	Deloitte Access Economics regional general equilibrium model
EU	European Union
FTE	Full-time equivalent
GDP	Gross domestic product
HortNZ	Horticulture New Zealand
IO	Input-Output
LSF	Living Standards Framework
LUC	Land Use Class
NPS	National Policy Statement
PVGA	Pukekohe Vegetable Growers Association
RSE	Recognised Seasonal Employer
UK	United Kingdom

“When you live in Pukekohe you can’t really see the urban creep because it’s a bit at a time – but it’s really obvious now.” – Bharat Jivan, Jivan Produce

# Foreword

Horticulture is one of the success stories of New Zealand's primary industries. In 2017, the industry generated \$5.68 billion in value. Export revenue has grown nearly 50% in five years, illustrating the trust the world places in New Zealand-grown food, and the country's ability to meet that demand.

But the industry cannot rest. New Zealand faces opportunities with a growing population and the need to grow fresh produce. Nowhere is this more apparent than in Auckland, and its surrounding rural land. The population is set to rise to 2.3 million by 2043, straining natural resources and infrastructure. And growers are feeling that pressure. The Pukekohe growing hub straddles the Auckland and Waikato District boundaries, and it is key to sustaining the fresh food supply to the country's largest city. The squeeze on prime growing land in the Pukekohe hub, access to water, and the tensions between the existing industry and new neighbourhoods all mean a more considered and concerted approach to planning is needed. It is the right time to start the conversation about New Zealand's sustainable food supply with a focus on a growing area experiencing change.

Our economic analysis suggests that, over the next 25 years, the Pukekohe hub could face constrained horticulture production. If left unchecked, less production could result in lost economic value, higher prices for customers, and job losses for the industry itself and the sectors it supports.

The value the Pukekohe hub provides is not just monetary. By using the Treasury's Living Standards Framework, we have outlined the Social, Human and Natural values that make this area special. At the same time, we have also described the constraints and issues the hub is experiencing.

The challenges to ensuring the Pukekohe hub remains a bulwark of New Zealand's food supply are not small. Some run up against current planning and policy settings. Success requires central and local government to work with the industry to best protect and enhance this natural asset, and sustainable business models.

In undertaking the research for this report, we spoke to a range of growers, retailers and distributors, all of whom provided valuable views on the importance of the Pukekohe growing hub.

We hope our New Zealand Food Story provides you with valuable insights into the health of the industry, and furthers the conversation on the strategic importance of the country's food security.

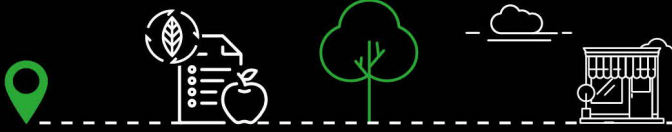


Andrew Gibbs  
Partner  
Deloitte

# The Pukekohe growing hub

## A national asset of opportunity

Pukekohe's hub contributes \$261m to GDP

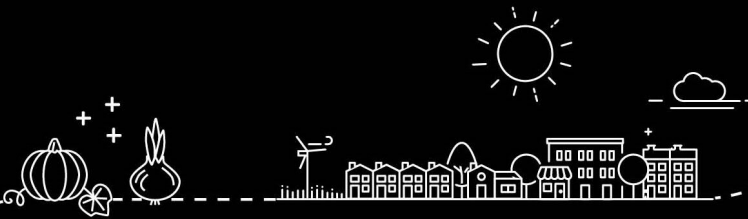


Fruit and vegetables grown in the hub provide nutritional benefits and food at an affordable price

Intergenerational family-owned businesses and a multi-cultural workforce instil a sense of civic pride

### Yet the hub is under threat:

Auckland's population is expected to grow almost **37%** in the next 25 years



Population growth and changing consumer preferences mean demand for fruit and vegetables will increase

Pukekohe town's population is expected to grow to 50,000 by 2043



Urban encroachment means productive land is being used for other purposes

When town meets country, tensions can arise (reverse sensitivities)

Growers are struggling with the cost of land, intensive growing, competition for water, and sourcing labour




Some growers are diversifying their operations away from Pukekohe to areas like the Matamata - Piako district



### The right balance must be struck:

 Auckland and the Waikato need to make the most of this productive land to contribute to New Zealand's food security



 The tensions of land use, water access and maintaining cohesive communities need to be managed

Or the hub faces an alternate future where growth is constrained, domestic food supply is diminished, and the industry loses up to \$1.1 billion over the next 25 years

The four capitals of wellbeing need to be balanced for the benefit of New Zealand

# Executive Summary

New Zealand's domestic vegetable production is becoming more important. New Zealanders are fortunate to have the majority of their fresh fruit and vegetables locally grown and available for domestic consumption, spending over \$1.3 billion on vegetables and approximately \$970 million on fruit annually.<sup>1</sup> This is set to increase further as our population expands and consumer preferences change; however, there are significant challenges that could stand in the way of increasing production to meet this growing appetite.

An increasing consumer awareness of the ability of food to advance or decline wellbeing has resulted in a clear demand shift towards consumption of products with perceived health benefits. The International Food Policy Research Institute estimates that between 2010 and 2050, the demand for fruit and vegetables will increase by 90%, and significantly exceed estimated global population growth of 30%. Closer to home, a recent survey by the Ministry of Health showed that average vegetable consumption per capita is greater than average fruit consumption.

Yet, our horticulture land is diminishing. Between 1996 and 2012 urban growth saw the size of towns and cities grow by 10%. From 2002 to 2016 the country's vegetable-growing land reduced by 30%.<sup>2</sup> Significant, and often swift, land use change in New Zealand is putting increased pressure on our growing hubs to keep up with the mounting demand for fruit and vegetables.

In this context, this report focuses on one of New Zealand's food growing hubs, Pukekohe ('Pukekohe hub' or the 'hub'). For an area accounting for only 3.8% of New Zealand's total hectares of fruit and vegetable production, the Pukekohe hub punches far above its weight. The revenue generated by the hub's horticulture businesses of \$327 million equates to 26% of New Zealand's total domestic value of vegetable production, and to a lesser extent of fruit

## Defining the Pukekohe growing hub

The Pukekohe hub is an area comprising 4,359 hectares of some of New Zealand's most fertile and productive soils. The hub's temperate, forgiving climate and proximity to essential transport routes makes it ideally located to supply year-round vegetables to our biggest – and fastest growing – region, Auckland.

For the purposes of this report, the Pukekohe hub encompasses Paerata and Patumahoe to the North, Aka Aka to the west, Pokeno to the east and borders on Onewhero and Pukekawa to the south (refer Figure 2 on page 13). Horticulture activities, referenced in this report, includes the growing and primary processing of defined produce within the hub, and also includes

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<sup>1</sup> Plant & Food research, FreshFacts New Zealand Horticulture 2017, <<http://www.freshfacts.co.nz/#booklets>>

<sup>2</sup> Ministry for the Environment, Our land 2018, <<http://www.mfe.govt.nz/sites/default/files/media/RMA/Our-land-2018-final.pdf>>

the processing of produce grown outside the hub, if the processing occurs within the hub.

Horticulture cultivation in this growing hub is largely focused on the supply of domestic fresh vegetables including potatoes, carrots, leafy greens, brassicas, tomatoes and onions. The Pukekohe hub is world famous for its Pukekohe Longkeeper onion, which is exported globally. Kiwifruit are also grown in the northwest of the hub, largely for export.

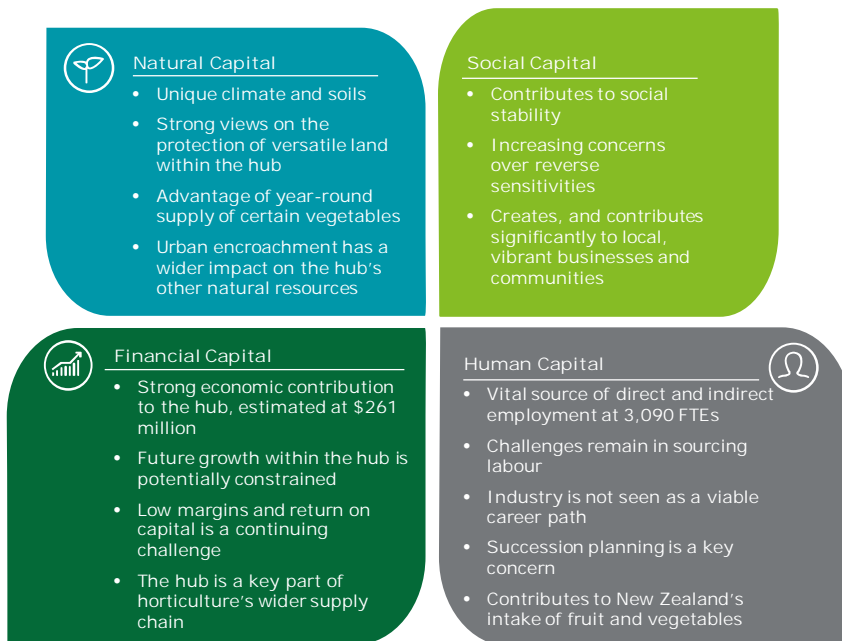
### Measuring the value of the Pukekohe hub

The notion of measuring value through a multi-dimensional platform is gaining traction, with the Government formally making a change towards broader reporting through the Treasury's Living Standards Framework (LSF). The LSF draws on the concept of fostering holistic wellbeing through reporting on the growth and distribution of four interdependent capitals: social; financial; human; and natural capital. Finance Minister Grant Robertson has said the Government will use Treasury's LSF to develop the world's first wellbeing Budget in 2019 to measure the country's success.<sup>3</sup>

Deloitte used the four capitals of the LSF as a framework to provide a comprehensive picture of the wider value contributed – and constraints experienced – by the Pukekohe hub in each of the capitals. This report does not weight one capital more or less than another, nor does it propose trade-offs between capitals, but Deloitte do believe looking at the value of the hub through this holistic lens can assist future decision-makers.

Figure 1 below presents a summary of the hub's key contributors to value – and limitations to these – under each capital.

Figure 1: Summary of the economic, social and wider values, and constraints of, the Pukekohe hub



Source: Deloitte primary research

<sup>3</sup> Hon Grant Robertson, Budget Speech, <<https://www.beehive.govt.nz/speech/budget-speech-2018>>



### Financial capital

The horticulture industry within the Pukekohe hub is a wealth creating industry, which makes a strong economic contribution to the hub. Deloitte has estimated the current economic contribution of the Pukekohe hub's horticulture industry to be \$261 million. This relatively small growing hub, 0.01% of the Auckland region, contributes a respectable 0.3% to Auckland's economy.

This total contribution can be split into two distinct categories; direct contribution and indirect contribution of the horticulture industry:

- The hub's horticulture industry directly contributes approximately \$86 million per annum, in value-added terms, to the regional economy.
- The hub's horticulture industry indirect contribution, reflecting expenditure on intermediate inputs such as agriculture support services, water, machinery, feed, fertiliser and seed, is \$175 million per annum, in value-added terms.

The hub's proximity to its main market, Auckland, and easy access to transport routes is key factor to maintaining the hub's economic contribution. Freight makes up a significant portion of the overall cost of produce, and therefore, being close to markets is critical to preserving growers' margins.

But what about the other, less quantifiable benefits and contributions made by the Pukekohe hub? Understanding the value of the social and wider benefits of the Pukekohe hub is not as straight-forward. To support the economic quantification of value, Deloitte undertook industry consultations with a diverse mix of industry participants operating in the Pukekohe hub, including growers, distributors and retailers.

### Natural capital

The land within the Pukekohe hub largely consists of volcanic, free-draining soils, which are classed as Land Use Class ('LUC') 1 and LUC 2, and are known as 'versatile' or 'elite'. LUC 1 or 2 land has a higher ability to sustain agricultural production, given its enhanced natural attributes such as soil and rock type, climate, reduced potential for erosion and taking into account past land use.

The area also benefits from a unique, moderate climate, which is generally frost-free and allows for year-round supply of certain vegetables such as leafy greens. This, and its proximity to the Auckland market, makes the Pukekohe hub a key part of the wider horticulture supply chain, providing out-of-season produce to other parts of New Zealand.

Urban encroachment has largely driven the limited availability and rising cost of prime growing land in the hub. As a result, growers are left with fewer growth and investment choices, and cropping in the Pukekohe hub has become increasingly intensive in recent years, meaning growers are forced to grow more on less land. Crop rotations are an essential management practice in horticulture but, due to these pressures, growers in the hub often find themselves taking chances and planting their prime crop more frequently, to the potential detriment of crop performance, and soil and water quality.

### Social capital

The value of the Pukekohe hub's legacy horticulture businesses to the area's social fabric is palpable. Intergenerational employment, sustained by these longstanding businesses, contributes to the social stability of the area.

Growers in the hub are known to be generous; regularly and willingly, contributing to fundraising, local marae, sponsorship of the Blues or the Steelers, and events such as school calf club days. Growers' deep involvement in their communities also extends to sports clubs and teams with some growers involved with the Pukekohe Indian Sports Club since the day it was established in 1945.

The importance of social cohesion and its effects on wellbeing are well-documented, and should not be underestimated. However, the rapid housing development within the Pukekohe hub, with a number of areas being designated as Special Housing Areas by the Auckland Council, has resulted in wider impacts on the local horticulture industry besides just the loss of exceedingly fertile, productive land. The intensification of urban sprawl is a concern for some growers, who feel the growth is diluting the small-town, community feel of the area, and changing the culture and social fabric of the hub.

Growers also report increasing instances of reverse sensitivities resulting in restrictions on their already established operations, such as spreading fertiliser and environmental noise. Growers feel their commitment to the community allows them the social license to operate, and goes some way to alleviate the issue of reverse sensitivities, but note that the hub would benefit from more considered planning around land use and incorporating appropriate 'buffers'.

### Human capital

The Ministry of Health recommends New Zealand adults eat at least three serves of vegetables and two of fruit each day. According to the most recent New Zealand Health Survey, 62% of all adults meet the minimum vegetable intake requirement, and 54% of all adults meet the minimum fruit intake requirement. The hub's produce directly contributes to New Zealand's high intake of fruit and vegetables.

The Pukekohe hub's workforce is multicultural, reflecting the changing demographics of New Zealand, and deeply ingrained in the small, local communities around them. In 2017, the hub employed 1,458 Full-time equivalent ('FTE') employees in the growing of vegetables, equivalent to 22% of the total 6,700 FTE employees in vegetable growing employment in New Zealand.

Over time, the industry has also contributed to creating vibrant and sustainable local communities and businesses, which may not have been there if not for the growing hub. Over 1,500 FTE jobs have been created in industries that provide services to the Pukekohe hub.

Despite providing significant employment opportunities, the industry is challenged with an undersupply of labour. Growers felt the lack of skilled talent coming into the industry, particularly as it is not promoted as a viable career path, was one of the biggest threats to the hub's succession planning and future horticulture industry. As a result, growers have become increasingly more connected with education providers to develop

appropriately technical and specialised courses, and promote the industry to those who might be academically inclined to related disciplines, including agronomy and science.

### Imagining a world where horticulture production can't keep up

As Auckland's population grows over the next 25 years, the Pukekohe hub's horticulture industry will increasingly need to compete with alternative uses for land. Alongside land access challenges, the industry may need to address other limitations to production, such as biosecurity risks, urban encroachment, availability of skilled labour, and water access issues to ensure supply keeps up with Auckland's growing demand.

To quantify the economic impact of these challenges in the Pukekohe hub, Deloitte compared a scenario where production can grow to meet increasing regional demand ('base case') against a counterfactual scenario, where horticulture production is constrained and unable to meet demand over the next 25 years, ('the counterfactual').

As a result of constraining the production growth of Pukekohe's horticulture hub, consumers are expected to be worse off, as they face higher prices and reduced quality of the produce they purchase. For example, if a lettuce is \$3.50 in 2043 under base case, then a lettuce is expected to be \$5.08 under the counterfactual at the end of the period.

The loss of growth in Pukekohe's horticulture hub will result in GDP of \$850 million lower than it would otherwise would have been over the next 25 years. This loss could increase to \$1.1 billion over the next 25 years if growers are further limited in their ability to respond to production constraints.

It is also estimated that the counterfactual will result in 3,500 fewer FTE jobs in the Auckland region compared to base case by 2043. This could increase to 4,500 fewer FTEs if growers are limited in their ability to respond to production constraints.

The value of production will increase at a much slower rate in the counterfactual than forecast under base case, such that the value of production is expected to be within the range of 23% to 28% lower than base case by 2043. Similarly, the volume of fruit and vegetable production will decrease between 46% and 55%.

If the constraints on horticulture can be managed effectively over the coming 25 years, these economic impacts, job losses and price impacts may be lessened.

### Where to from here?

The Pukekohe hub is an ecosystem that contributes widely across the four capitals and is a significant contributor to the Auckland regional economy. But this ecosystem is under pressure and at risk of slowly being eroded as competing uses and demands take centre stage.

Despite the hub's natural advantage and strategic location, its current place as a growing region is not assured. New Zealand's rapidly changing land use has been dramatic enough to prompt Environment Minister David Parker to direct officials to begin working on a National Policy Statement

(‘NPS’) for Versatile Land and High Class Soils,<sup>4</sup> the purpose of which would be to provide guidance on balancing the needs of urban growth and food production.

While many industry participants interviewed held strong views on the protection of versatile land in the Pukekohe hub, with growers recognising the importance of protecting land for food production, there were varying opinions on whether or not a tool to secure prime growing was the right way to go about this. There is a strong desire to ensure that any policy tool does not limit or remove a land owner’s use and sale options, with some acknowledging the potential for policy settings to create unintended commercial outcomes.

This view was countered by others who believed that if the industry were adequately consulted in the formation of the NPS, including discussions at a local level to address unique regional aspects, the NPS could be an appropriate tool for land management.

As the future constraints to production such as labour and access to prime land start to hit home, growers have also expressed concerns over New Zealand’s lack of a domestic food security policy. Given the current global political stability and no shortage of imports, a food security policy has not been high on the agenda.

But with our unique environment and vulnerability to biosecurity risks, New Zealanders may not be in a position to import all the fresh vegetables they wish to import should domestic production be lost. An NPS on versatile land, which ensures land for primary production purposes, could be a useful first step in establishing New Zealand’s domestic food security plan and dealing with issues on reverse sensitivities.

### Starting the conversation on food security

From its abundant, prime versatile land to its strategic location and place within New Zealand’s wider value chain, the Pukekohe hub could not be better designed as a growing hub. Future growth and innovation for the hub will likely be driven by increasing skilled labour into the industry, developing new cultivars, and further investment in technology and automation of packhouses, operations and farm management practices.

But with current and future challenges in horticulture production, how do New Zealanders protect and enhance what the Pukekohe hub adds to the four capitals of wellbeing? If the demand is growing, then the response from the value chain has to be productivity increases within our environmental constraints. Deloitte therefore recommends:

1. Considered planning on, and adequate tools for, land use to balance the needs of housing and horticulture.
2. Increased use of technology to manage the intensification of cropping within environmental limits.
3. Investment in the development of new varieties of produce to manage changing conditions, diseases and consumer preferences.

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<sup>4</sup> Stuff, Urban expansion gobbling up some of New Zealand’s most versatile land, <<https://www.beehive.govt.nz/release/environment-report-highlights-serious-land-issues>>

4. More funding and investment in horticulture education to provide for, and attract, skilled talent into the industry.
5. Sustainable margins and returns on capital by developing a more commercial, demand driven supply chain.
6. More certainty on access to resources through deliberate water allocation systems that balance household and horticulture demands.

Ultimately, this great natural system is being transformed with a resulting loss of arable land. The challenge is to persuade fellow New Zealanders that we need to consider the trade-offs being made. As Environment Minister David Parker says, “we have to ensure we have enough land to build the houses people need, but we must protect our most productive areas too.”<sup>5</sup>

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<sup>5</sup> Hon David Parker, Environment report highlights serious land issues, <<https://www.beehive.govt.nz/release/environment-report-highlights-serious-land-issues>>

# A food hub for New Zealand

## Horticulture in New Zealand

Horticulture is one of the success stories of New Zealand's primary industries. Horticulture New Zealand defines the horticulture sector (the 'industry') as all fruit and vegetables, including processed vegetables, and excluding wine, which encompasses 5,000 commercial fruit and vegetable growers.<sup>6</sup> In 2017, the industry generated \$5.68 billion in value, with export revenue accounting for \$3.49 billion having increased by 49% over the last five years.<sup>7</sup> The growing strength of horticulture exports illustrates the trust the world places in New Zealand-grown food, and our ability to meet that demand.

New Zealand's horticulture exports are supported by a strong domestic base with domestic spend on fruit and vegetables reaching \$2.24 billion in 2017.<sup>8</sup> Vegetables are largely a domestic story, with most supply grown for local consumption. New Zealand's domestic expenditure on vegetables is valued at \$1.3 billion, with exports of fresh vegetables, like onions, and processed vegetables, such as frozen potato fries, contributing \$614 million for the year ended June 2017.<sup>9</sup>

## The Pukekohe growing hub

New Zealanders are fortunate to have the majority of their fresh vegetables cultivated locally in various growing hubs dotted around the country. One of New Zealand's key growing hubs is known as the Pukekohe hub, an area encompassing 4,359 hectares of highly efficient, productive soils, straddling the Auckland and Waikato regional boundaries.<sup>10</sup>

The Pukekohe hub grows a wide variety of fruit and vegetables, including the world famous Pukekohe Longkeeper onion, which was first planted in the 1920s when local grower John Turbot crossed a Spanish brown and a Spanish straw onion. The hub's excellent soil types and growing conditions allow for high quality produce, including its unique, early potatoes and spring carrots, to be grown almost year-round providing supply around the country.

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<sup>6</sup> Horticulture New Zealand, Structure & Membership, <<http://www.hortnz.co.nz/membership/structure-membership/> (accessed 29 June 2018)>

<sup>7</sup> Ministry for Primary Industries, June 2018, Situation and Outlook for Primary Industries

<sup>8</sup> Plant & Food research, FreshFacts New Zealand Horticulture 2017, <<http://www.freshfacts.co.nz/#booklets>>

<sup>9</sup> Ibid

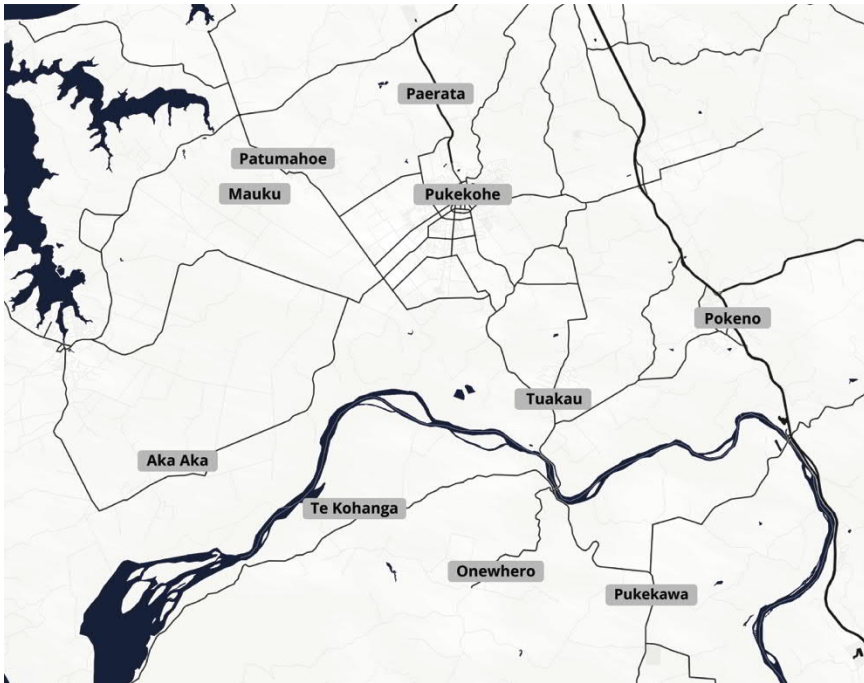
<sup>10</sup> This hectares was determined by Statistics New Zealand based on the 2017 Agriculture Census data for this study

The hub's close proximity to New Zealand's largest market, Auckland, is another unique advantage. The hub's easy and direct access to transport routes and ports make it an efficient and vital part of the horticulture supply chain for the Auckland region, and a key source of supply for Auckland's growing population. The hub's strategic location also has the advantage of allowing for just-in-time, same day supply of vegetables when needed.

### Defining the Pukekohe hub

For the purpose of this report, Deloitte defines the Pukekohe hub as the area covering Pukekohe, Patumahoe, Mauku, Aka Aka, Puni, Te Kohanga, Onewhero, Pukekawa, Tuakau and borders on Pokeno and Paerata (refer to Figure 2).

Figure 2: The Pukekohe hub



Geographically, the Pukekohe hub is advantaged by having a generally frost-free climate and owes its rich, fertile, productive soils to a volcanic eruption in the central plateau 250,000 years ago.<sup>11</sup> This soil is classified LUC 1, which means the land can be cultivated continuously, making it good for intensive cropping, and can sustain two or three crop rotations a year.

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<sup>11</sup> NZ Herald, Urban sprawl and the land that keeps on giving, <[https://www.nzherald.co.nz/business/news/article.cfm?c\\_id=3&objectid=11944763](https://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=11944763)>

## Pukekohe hub history

The Pukekohe area was established during the 1800s when large areas of productive, volcanic soil became available after dense bush was cleared. The soil proved to be prime land for cropping and saw the rise of market gardens established to support the growth of the large Auckland market.<sup>12</sup>

From 1890 to 1940, the number of market gardens increased, as new entrants entered the industry. Following the exhaustion of Otago's gold fields, many young relatives of the Chinese gold prospectors took up market gardening and, in the 1920s, Indian immigrants from Punjab settled in Pukekohe and began growing potatoes. The expansion of transport infrastructure around the country allowed market gardens to develop in districts that were some distance from their main markets; in particular, Pukekohe, which emerged as an important vegetable growing hub.<sup>13</sup>

Industry participants broadly agree that since the 1990s there has been a consolidation of smaller growers in the hub into larger, more corporatised growers, which are often vertically integrated and geographically diversified. Some smaller, more boutique growers still exist.<sup>14</sup>

An important group for growers in the hub is the Pukekohe Vegetable Growers Association (PVGA) which is celebrating its centenary in 2018 – 100 years of support for growers throughout the Auckland and Waikato regions.<sup>15</sup> The PVGA has operated as a grower organisation since the early 1900s, augmented by the success of pioneering Chinese and Indian growers in the 1920s, and has contributed to making Pukekohe the centre of vegetable production for the upper North Island. Today, the PVGA represents over 230 vegetable growing businesses from local family-run operations to geographically diversified corporate growers.

## Pukekohe hub crops and seasonality

Pukekohe's climate and soils gives the area the ability to supply some vegetables, such as leafy greens and brassicas, on a year round basis, while other vegetables, such as early potatoes and spring carrots, are in season in Pukekohe earlier than the rest of New Zealand. Figure 3 presents growers average planting and harvesting cycle for the major Pukekohe hub crops.<sup>16</sup>

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<sup>12</sup> A. H. McLintock, (1966), 'PUKEKOHE', from An Encyclopedia of New Zealand, <<https://teara.govt.nz/en/1966/pukekohe>>

<sup>13</sup> Maggy Wassilieff, Market gardens and production nurseries, <<http://www.TeAra.govt.nz/en/market-gardens-and-production-nurseries/page-2>>

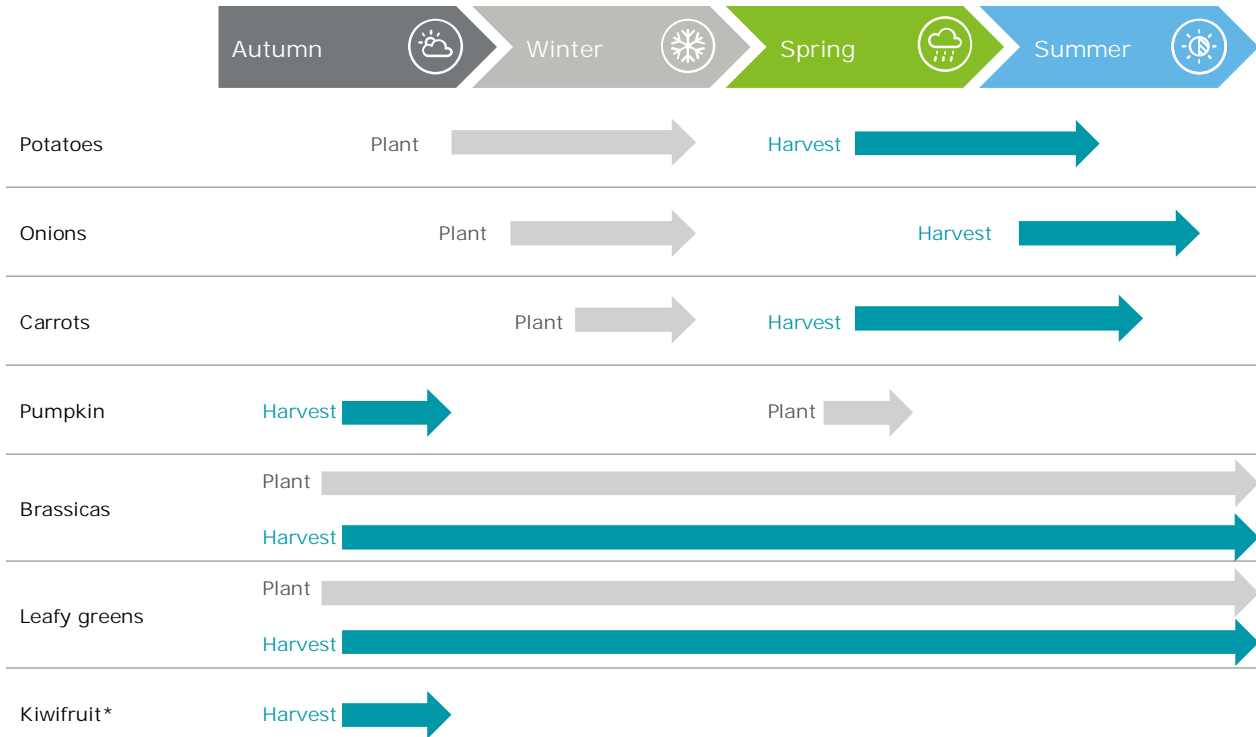
<sup>14</sup> Deloitte primary research

<sup>15</sup> Pukekohe Vegetable Growers Association, About us, <<https://www.pvga.org.nz>> (accessed 11 June 2018)

<sup>16</sup> Deloitte primary research



Figure 3: Seasonality of crops grown in the Pukekohe hub



\*Kiwifruit is not an annual crop. Vines are pruned in early winter and lie dormant until new growth begins in spring.

Source: Deloitte Primary Research

Figure 3 highlights a key point about seasonality. While consumers are largely able to enjoy their vegetable produce year round, as result of the advent of cold stores, a large majority of the counter-seasonal fresh produce originates from the hub. For example, potatoes and carrots are typically only planted from September to November once the frost has passed, meaning potatoes and carrots eaten during this period are old season produce, which has been stored.<sup>17</sup> In contrast, the Pukekohe hub begins to harvest its carrots and potatoes earlier, in the spring. This is a key advantage to the hub - managing New Zealand's vegetable supply chain, while also directly satisfying consumer preferences for fresh, healthy food.

<sup>17</sup> 5+ A Day, <<http://www.5aday.co.nz/>>

## RC Hari & Sons – The unique nature of Pukekohe is worth protecting

RC Hari began cropping in the Pukekohe area in the late 1930s, mainly potatoes, beetroot and other root crops. He was also a founding member of the Pukekohe Indian Hockey Club. A photograph hangs in the RC Hari & Sons staffroom of the 1945 men's team, with RC Hari in the front row as coach.

73 years later, RC Hari's grandson, Kiran Hari, is following in his forebear's footsteps, in more ways than one. He is heavily involved in hockey at the Pukekohe Indian Sports Club, as well as being one of four directors at the family business – along with his father, uncle, and cousin, Pravin.

Pravin Hari, like Kiran, is passionate about sport. The New Zealand and All Blacks flags fly at the gates to the company's Pollock Road property, and they raise the Indian flag on 15 August each year - Indian Independence Day.

With the family's roots in the area going back nearly 100 years, the cousins feel deeply about the contribution horticulture makes to Pukekohe's communities.

"Growers are pretty generous," says Kiran. "We donate vegetables to fundraisers and calf club days, and to local marae if they're hosting tangi or other events. Because different parts of the area also grow different types of produce, we'll often do swaps so fundraisers get a good mix of fruit and vegetables."

Both Kiran and Pravin take their advocacy roles seriously. Kiran is on the Board of Vegetables New Zealand Inc, and Pravin is the President of the Pukekohe Vegetables Growers Association, to which Kiran also belongs.

As students at Pukekohe High, the cousins say most of their classmates' families were connected to horticulture in some way. But, with pressure for living space seeing developments spread into the area, they worry the industry – and the jobs it creates – will suffer.

"A National Policy Statement to protect elite soils and productive land would be good," says Pravin. "There needs to be a rural zone, as farming on land very close to town can be difficult for both growers and their neighbours – we've recently sold some productive land on the town fringe because of that very reason."

"Water is also a massive part of our business, and the structure of a daily take is difficult. For two or three months a grower might not use their take but, in other times, they'll need all the water they can get."

"We don't believe we would be able to survive a drought if we were banned from using our bore water."

Pukekohe is such a growing hub that a seemingly small, localised issue can be felt throughout the country. Kiran says when the blackrot disease took hold on growers' brassica crops – including theirs – consumers saw the effects: "prices doubled."

"We limped on without any assistance because our other crops helped us ride out the tough times."

But the challenges around land management and urban planning don't dim their enthusiasm for their family business.

"We don't want to sell our land," says Pravin. "We believe there is long-term gain from being part of this industry. We just want to it be sustainable, in terms of natural, physical and human assets so these factors can be rolled together and businesses can run at a profit."

"Once you lose a grower, it can be very hard to get them back."

## Key issues for the hub

Despite these natural and strategic advantages, the hub's place as a growing region is not secure. While urban sprawl in rural towns with close proximity to major cities is not unusual, the impact on the Pukekohe hub is. The loss of productive land to urbanisation in the hub is not just a land use change, but has implications for our domestic food security.

The Auckland region is expected to grow by 37% to a population of 2.3 million between 2018 and 2043. This, coupled with changing consumer preferences to a healthier, more plant-based diet, signals a wave of increased demand for horticulture produce, which the Pukekohe hub is ideally located to support.

Yet, New Zealand is seeing a reduction in land available for cultivation and a mounting disconnect between urban consumers and their food sources.<sup>18</sup> With further growth in supply potentially constrained, and demand on an upward trend, New Zealand runs the risk of not being able to feed its own population unless the value and contribution made by these growing regions is understood.

## New Zealand's domestic food story: A focus on the Pukekohe hub

The value of horticulture is not just in the economic value of the crops themselves. The growth and evolution of horticulture provides economic and social benefits across tourism, trade, investment, skill development, productivity, and health and wellbeing. Yet, the value New Zealanders themselves place on horticulture is not as great as it could be.

To enhance the domestic food story, Horticulture New Zealand (HortNZ) has engaged Deloitte to undertake an analysis of the current economic, social and community benefits of fruit and vegetable growing, and primary processing, in the Pukekohe growing hub. Primary processing refers to processing, such as washing, cutting and packaging vegetables, within the defined area and includes produce grown outside the hub that is brought into the hub for processing.

This report focuses on the production and value of the major crops within the Pukekohe hub, including:

- Root crops such as potatoes (both fresh and processed), carrots and pumpkin
- Brassicas; in particular, cauliflower, cabbage, broccoli and Asian greens
- Leafy crops, such as lettuce and silverbeet
- Onions
- Tomatoes
- Kiwifruit

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18

Currán-Cournane, F. (2018) Land use pressures confronting finite land and soil resources- Pukekohe test case. Report prepared for Ministry for Primary Industries by Auckland Council. January 2018

This report will also delve into the end consumers of produce grown and processed in the hub, and explore the economic impact of a constraint to this horticulture production. Primary research was conducted through consultations with industry participants including relevant growers, distributors and retailers.

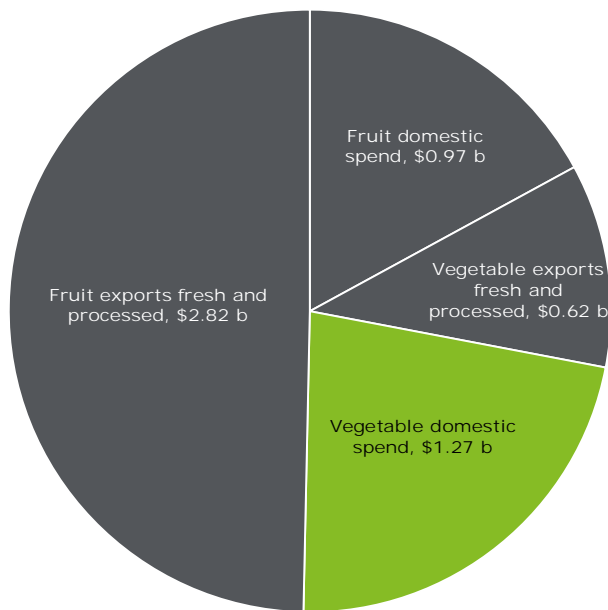
# Pukekohe hub in context

New Zealand produces significantly more fruit than vegetables. In 2017, the majority of our fruit production was exported at a value of \$2.8 billion. In that same year, New Zealand's related domestic spending on fruit was approximately \$970 million.

On the other hand, the value of vegetables exported sits at \$0.6 billion, with the majority of vegetables consumed domestically. New Zealanders spent \$1.3 billion on vegetables in 2017, accounting for 22% of the total value of New Zealand's horticulture industry (excluding wine and other).<sup>19</sup>

Because the Pukekohe hub predominately grows vegetables, this study focuses on the growing and processing of vegetables within horticulture, as illustrated in Figure 4.

Figure 4: This study focuses on a narrow segment of horticulture production



Source: Deloitte based on 2017 Fresh Facts underlying data

<sup>19</sup> Plant & Food Research, FreshFacts New Zealand Horticulture 2017, <<http://www.freshfacts.co.nz/#booklets>>

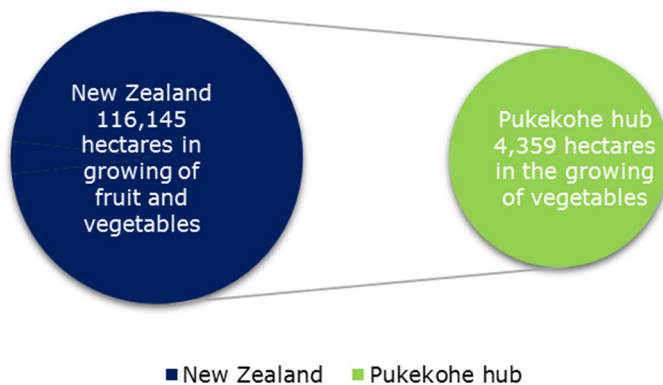
## The Pukekohe hub in context

The Pukekohe hub, particularly the area within the hub that is dedicated to the growing of fruit and vegetables, is relatively small compared to New Zealand's total hectares used for fruit and vegetable growing. Figure 5 illustrates that the hub accounts for only 3.8% of the total hectares of production in New Zealand.

In particular, the hectares within the Pukekohe hub used for the growing of vegetables only make up 8.9% of the total vegetable hectares in New Zealand.

Yet, when considering the revenue generated by horticulture, the hub becomes much more significant to the New Zealand horticulture industry. The revenue generated by the hub is \$327 million,<sup>20</sup> which equates to 26% of the nation's value of production on vegetables, and to a lesser extent on fruit.<sup>21</sup>

Figure 5: Horticulture Area and Revenue in the Pukekohe hub and New Zealand



Source: Deloitte based on 2017 Agriculture Census data

## Distribution of the Pukekohe hub's produce across distribution channels

Overall, imports of fresh vegetables into New Zealand is small relative to total domestic spend. Based on 2017 Fresh Facts data, imports for both fresh and frozen vegetables account for 10% of total domestic spend. This emphasises the importance of the domestic supply of vegetables.

<sup>20</sup> This figure is based on the primary data collected by Deloitte and provided revenue for the growing and first round of processing with the defined Pukekohe area.

<sup>21</sup> Within Pukekohe, horticulture growing is mostly focused on vegetables and a small proportion (2%) of New Zealand's total kiwifruit production. For this reason we reflected the percentage based on domestic spend of vegetables in New Zealand. According to Fresh Facts 2017, total spent on vegetables is \$1.3 billion. This was used as the basis to calculate the contribution of Pukekohe hub's contribution.

Vegetable production from the Pukekohe hub is predominately for the domestic fresh market – and is a significant share of this market. However, a small portion of production is designated for export. Of the major crops, onions are New Zealand's biggest export, heading to the United Kingdom ('UK'), European Union ('EU'), Japan, Indonesia and Malaysia. Potatoes are exported either fresh or frozen, mainly to the Pacific and Australia, while fresh carrots mainly go to Asia.

On the other end of the scale, leafy crops and brassicas are the least exported vegetables, suffering from a lack of market access, with produce going to select Asian markets such as Hong Kong, Japan, Malaysia and Thailand. Tomatoes are exported to Australia, Japan and the Pacific.<sup>22</sup>

Figure 6: Breakdown of distribution of the Pukekohe's hub produce



Source: Data received from growers, distributors, and Deloitte Analysis

According to growers and distributors in the Pukekohe hub, there are three key distribution channels. The most heavily used channel is retail, which distributes 83% of the hub's produce, and includes retailers such as Foodstuffs and Countdown. The other two channels are food services and exports, which distribute 7% and 10%, respectively.

#### Who is the end consumer of Pukekohe's produce?

With consumers increasingly aware of health concerns and demanding local food, it is important to understand the hub's end consumers, their preferences and consumption patterns.

While there is no comprehensive data source on food consumption for the Pukekohe hub's produce, this report outlines Deloitte's understanding of the end consumer based on interviews with retailers and distributors, as well as demographic and consumption data.

<sup>22</sup> Deloitte primary research; Onions New Zealand inc., <[www.onionsnz.com](http://www.onionsnz.com)>; Vegetables New Zealand, <[www.freshvegetables.co.nz](http://www.freshvegetables.co.nz)>; Potatoes New Zealand, <[www.potatoesnz.co.nz](http://www.potatoesnz.co.nz)>; TomatoesNZ, <[www.tomatoesnz.co.nz](http://www.tomatoesnz.co.nz)>

Industry distributors and retailers indicated the bulk of produce grown in the Pukekohe hub is distributed to Auckland, making the demographics of the city’s population a good proxy for the end consumer. According to Auckland Council, 59% of people in Auckland identify as New Zealand European, 23% identify as Asian, 11% identify as Maori and 15% as Pasifika.

### Increasing regional demand for Pukekohe’s hub produce

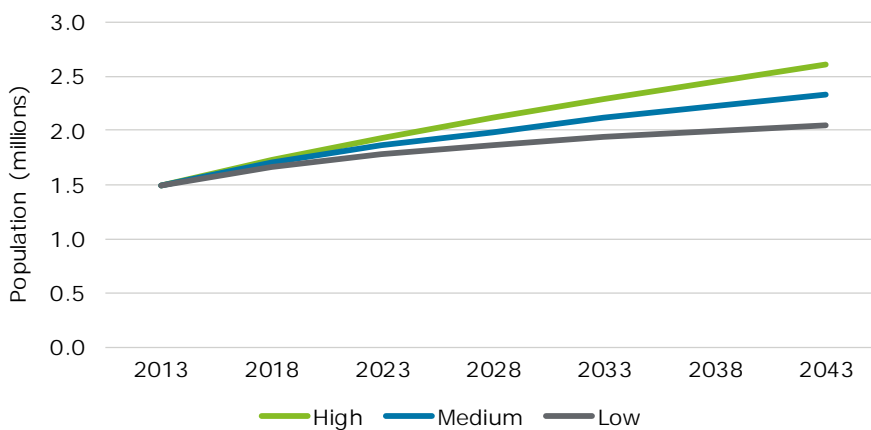
There is a rising demand for fresh fruit and vegetables in New Zealand. The average household expenditure on fruit and vegetables increased by 12% from 2012 to 2016, bringing average household expenditure to \$25 per week.<sup>23</sup> This increasing trend is expected to continue, and even more so for the Pukekohe hub’s produce. The key drivers for this expected growing demand are:

- Auckland’s growing population
- Changing consumer preferences
- A shift in demand resulting from consumer preferences

Auckland’s growing demand. Auckland’s population is expected to grow significantly over the next 25 years, straining the natural resources and infrastructure that the horticulture industry relies on. Population growth will likely result in increased demand for the Pukekohe hub’s produce.

According to Statistics New Zealand’s projections, Auckland’s population will grow between 23% (low growth scenario) and 50% (high growth scenario), between 2018 and 2043. This report will use the medium growth scenario of 37% as a reasonable prediction of Auckland’s population growth, which estimates a population of 2.3 million by 2043, or a 1.5% growth per annum.

Figure 7: Expected population growth in Auckland, 2013 to 2043



Source: Deloitte Analysis based on Statistics New Zealand data on subnational Population Projections

<sup>23</sup> Deloitte analysis based Stats NZ, Household Expenditure Statistics: Year ended June 2016, <[http://archive.stats.govt.nz/browse\\_for\\_stats/people\\_and\\_communities/HouseholdExpenditureStatistics\\_HOTPYeJun16/Commentary.aspx](http://archive.stats.govt.nz/browse_for_stats/people_and_communities/HouseholdExpenditureStatistics_HOTPYeJun16/Commentary.aspx)>



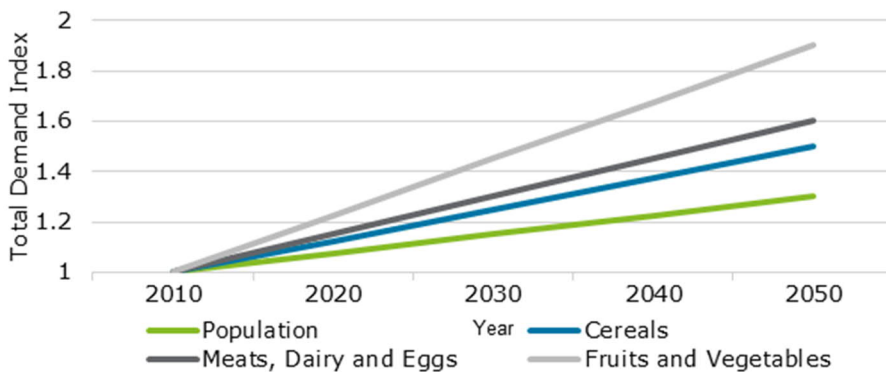
It is also expected that Pukekohe town will face the highest growth of secondary urban areas in New Zealand.<sup>24</sup> Pukekohe town's population is projected to grow by over 100%, from 21,000 people in 2013 to 50,000 people in 2043.

Consumer preferences are changing. There has been a clear demand shift to emulate consumers' increasing health concerns, and an increasing awareness of the ability of food to advance or decline their wellbeing. Consumption of products with perceived health benefits has risen as a result.

Today's consumers are taking into account more than just price, taste and convenience. Increasingly, customers are also considering safety (traceability of a product) and social impact, and displaying a preference for local food. It is estimated that 70% of consumers are concerned about where their fruit and vegetables come from and aim to purchase local produce to support local growers.<sup>25</sup>

Shift in demand resulting from changing consumer preferences. Changing consumer preferences are driving an increase in fruit and vegetable consumption. For example, the International Food Policy Research Institute estimates the rate of food demand growth will significantly exceed population growth.<sup>26</sup> Figure 8 illustrates that between 2010 and 2050 the world population is expected to grow by 30% while demand for fruit and vegetables demand will increase by 90%. This illustrates that growing demand is not only attributable to growing population but also to changing consumer preferences.

Figure 8: Projected global population growth and food demand, 2010 to 2050



Source: Deloitte analysis based on International Food Policy Research Institute

<sup>24</sup> Productivity Commission Analysis of Statistics New Zealand data

<sup>25</sup> Consumer NZ, SUBMISSION on Consumers' Right to Know (Country of Origin of Food) Bill,

<[https://d3c7odttnp7a2d.cloudfront.net/assets/4251/Consumers\\_\\_Right\\_to\\_Know\\_\\_Country\\_of\\_Origin\\_of\\_Food\\_\\_Bill\\_Submission\\_from\\_Consumer\\_NZ-online.pdf](https://d3c7odttnp7a2d.cloudfront.net/assets/4251/Consumers__Right_to_Know__Country_of_Origin_of_Food__Bill_Submission_from_Consumer_NZ-online.pdf)>

<sup>26</sup> International Food Policy Research Institute, 2017 World Population Day 2017: IFPRI models impact of population growth on demand for food, <<http://www.ifpri.org/blog/world-population-day-2017-ifpri-models-impact-population-growth-demand-food>>

### How will population growth and changing consumer preferences affect demand for the Pukekohe hub's produce?

The combination of population growth and changing consumer preferences towards health products is resulting in strong demand for fresh fruit and vegetables. This trend may also be stronger in Auckland, where population growth and income per capita growth are above the national average, resulting in an expectation that demand for the Pukekohe hub's produce will rise more than demand for produce from other regions.

Deloitte Access Economics estimates the Auckland region will see cumulative annual demand growth of 1.2% for fruit and vegetables year on year through to 2043. By 2043, demand will be 33% higher than it is in 2018, which is slightly below population growth, as not everyone will consume the same amount of fruit and vegetables. This is a conservative assumption given that international studies described above predict that demand for vegetables will increase significantly more than population growth.

To realise the full potential of the hub's horticulture industry, it is important to take into account growing demand for horticulture to ensure that the Pukekohe hub can continue to feed a hungrier Auckland.

# The value of the Pukekohe hub's horticulture

## Introduction

The dollar value of the Pukekohe hub's horticulture industry is quantifiable, as illustrated by the preceding sections. But what about the elements that are more intangible? How does New Zealand place a value on the strong communities, fertile soil and talented people, which all contribute to the hub's growing success?

To round out the economic quantification of value, Deloitte spoke to a diverse mix of growers, distributors and retailers about Pukekohe hub's key points of difference, value-add proposition, and the challenges and constraints the area faces. This section uses both quantitative and qualitative data to outline the economic, social and natural value of the hub.

### A framework for value

Reporting on value beyond the narrow measures of economic growth and contribution is something the New Zealand Government ('Government') is formally making a change towards through its Living Standards Framework ('LSF'). The LSF draws on an analysis from the Organisation of Economic Development and Cooperation ('OECD') of wider indicators of wellbeing, including human, social and natural capital. Finance Minister Grant Robertson has said the Government will use Treasury's LSF to develop the world's first wellbeing Budget in 2019 to measure the country's success.<sup>27</sup>

The LSF uses the concept of four capitals, as depicted in the diagram alongside, as a measure of wellbeing. Natural capital encompasses all aspects of the natural environment including land, soil, water, minerals, plants, animals, and other natural resources that support life and human activity. Human capital refers to the bank of skills and knowledge, and physical and mental health which enables people to participate fully in work, study, recreation and society. Social capital describes the norms and values that underpin society such as trust, the rule of law and connections between people and communities. Lastly, financial capital refers to physical and financial assets that directly support incomes and material living conditions.



<sup>27</sup> Hon Grant Robertson, Budget Speech, <<https://www.beehive.govt.nz/speech/budget-speech-2018>>

As Treasury Secretary Gabriel Makhoul said in March 2018, the framework represents a continuation of the effort in New Zealand to take a more holistic approach towards measuring wellbeing, recognising that traditional economic and financial measures miss some important aspects that contribute to our standard of living, not just for the current generation, but also for future generations.<sup>28</sup>

Deloitte are putting that to the test here, in order to draw out the benefits – and constraints – the industry experiences in each of the capitals. We are not weighting one capital more or less than another, nor are we proposing trade-offs between capitals, but Deloitte do believe a well-rounded picture of the hub's horticulture industry's benefits and value can be presented here, which can assist future decision-makers.

### Natural capital

The area's rich, productive soils and temperate growing climate have attracted settlers to the area since the early 1900s. A number of local growers Deloitte spoke to referred to the local Marae – Nga Hau e Wha – , meaning 'the crossroads of four winds' or the 'meeting place of four tribes'. "Local Māori have known for a long time the area was a place to grow their crops," says Balle Bros' Dacey Balle.

The Pukekohe hub has a unique climate and soils. Pukekohe, meaning the "hill of the kohekohe", New Zealand's native mahogany, together with the nearby Bombay Hills forms Auckland's natural southern border. The Pukekohe hub's generally frost-free climate allows for year-round growing and supply of certain vegetables, including leafy greens and new season potatoes. Many of its paddocks are of volcanic, free-draining soils, which are classed as LUC 1 and LUC 2, and are known as 'versatile' or 'elite'. Consequently, this relatively small patch of land makes a big contribution to feeding the country's largest city, while also providing out-of-season produce to the colder climates of the South Island.

Yet the hub's place as a growing mecca is not assured. Population growth has seen prime growing land built over with houses or subdivided into lifestyle blocks.<sup>29</sup> The 2018 Our Land report from the Ministry for the Environment and Statistics New Zealand shows, overall, there have been significant shifts in land use throughout the country over the past two decades.<sup>30</sup> It has happened gradually in Pukekohe town over that time. "When you live in Pukekohe you can't really see the urban creep because it's a bit at a time – but it's really obvious now," says Bharat Jivan of Jivan Produce.

The scale and value of the hub's production means urbanisation presents a particularly serious threat to horticulture – if only because of the permanence of land conversion. Once land is lost to housing, for example, it's highly unlikely it will ever revert to being used for growing or cropping.

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<sup>28</sup> Scoop, Speech: Natural Capital and the Living Standards Framework, <<http://www.scoop.co.nz/stories/PO1803/S00108/speech-natural-capital-and-the-living-standards-framework.htm>>

<sup>29</sup> Fiona Curran-Cournane (2018), Land pressures and confronting finite land and soil resources: Pukekohe test case

<sup>30</sup> Ministry for the Environment, Our land 2018, <<http://www.mfe.govt.nz/sites/default/files/media/RMA/Our-land-2018-final.pdf>>

That said, Auckland is not growing unchecked and unplanned. Auckland's 2017 Unitary Plan shows the majority of the urban sprawl is located to the north of the hub, but significant residential development is still slated for the hub. Three Special Housing Areas are designated within the Pukekohe hub being Anselmi Ridge, Belmont and the area surrounding Wesley College in Paerata.<sup>31</sup> A Special Housing Area is designated by the Auckland Council as an area where future urban investment can be optimised by building on the existing metropolitan urban area and leveraging off the Council's current investment focus.<sup>32</sup>

To add further pressure to growers' access to natural resources in the hub, the Waikato District Council's draft District Plan, released last year, also shows future urban growth planned on LUC 1-3 land around Tuakau and Pokeno.<sup>33</sup>

Urban encroachment has a wider impact on the hub's other natural resources.

For those growers still undertaking the bulk of their operations within the Pukekohe hub, they are working the land harder than before. As LUC 1 or LUC 2, the hub's soil is known to be exceptionally productive and efficient, allowing for multiple crop cycles in a single rotation. Growers acknowledged that the significant intensification of cropping in the hub in recent years is in part driven by the loss of available productive land, and the lack of sustainable economic rotational crops.

Growers rotate their crops in order to manage soil fertility and reduce the incidence of pests and disease. While an essential practice in horticulture, growers are faced with few economical choices to plant during this rotational period, and often have to take their chances and plant their prime crop more frequently. Some industry participants believe the current intensive cropping within the Pukekohe hub is not sustainable. Being able to rest horticulture land is vital, and growers want more flexibility to provide for rotations.

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<sup>31</sup> Auckland Council, Auckland Unitary Plan, <[http://unitaryplan.aucklandcouncil.govt.nz/pages/plan/Book.aspx?exhibit=AucklandUnitaryPlan\\_Print](http://unitaryplan.aucklandcouncil.govt.nz/pages/plan/Book.aspx?exhibit=AucklandUnitaryPlan_Print)>

<sup>32</sup> Auckland Council, Auckland Future Urban Land Supply Strategy, <<https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/housing-plans/Documents/future-urban-land-supply-strategy.pdf>>

<sup>33</sup> Waikato District Council, Intramaps, <<http://maps.waikatodistrict.govt.nz/IntraMaps90/?project=Waikato&configId=b2549ae1-f643-4ac6-9586-211ba985dd8f>>

## What is crop rotation and why is it important?

Crop rotation is the avoidance of continuous production of the same crop in the same soil by introduction of other crop species between repeated productions of a single crop. Over time, crops in a rotation generally perform better than those in continuous production.

Crop rotation is a key tool used to manage and replenish minerals in the soils. As some crops take up more of one nutrient than another, adequate crop rotation can reduce nutrient deficiencies. The use of a cover crop, such as clover, during crop rotation is also important for maintaining soil structure and protecting soil from erosion.

Rotating crops is important to break pest and disease cycles by removing host material for a period and reducing pest populations. The use of cover crops during rotations has the added advantage of suppressing weed populations compared to bare soil fallow between crops.

Rapid urban development also means increasing demand on other resources. Access to water is vital in this industry and a source of competitive advantage. "The industry is very focused on rain water harvesting, as this is the purest water and the most sustainable water to use," says Simon Watson, of NZ Hothouse. However the use of stored water is also important, particularly in the height of summer, with NZ Hothouse making use of a deep-water bore for 30% of its water needs.

But access to water is tightening up. Some growers expressed frustration with current council regulations for water storage and allocations, describing them as uneconomical and challenging to manage, given the seasonal nature of horticulture production.

Growers also believed water used for general household purposes was accorded greater importance than productive use, as illustrated in the Waikato Regional Council's Variation 6 to its Regional Plan, which prioritises water for domestic or municipal supply, and the replacement of existing water takes.<sup>34</sup> Growers felt that water for horticulture needs was already at a lower priority level, and with increasing residential development in the hub, would become even more so.

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<sup>34</sup> Waikato Regional Council, Proposed Waikato Regional Plan Variation 6, <[https://www.waikatoregion.govt.nz/assets/PageFiles/7062/n2141102\\_v1\\_OPERATI VE\\_version\\_-\\_Variation\\_No\\_\\_6March2012.pdf](https://www.waikatoregion.govt.nz/assets/PageFiles/7062/n2141102_v1_OPERATI VE_version_-_Variation_No__6March2012.pdf)>

## Financial capital

The horticulture industry with the Pukekohe hub makes a strong economic contribution

Deloitte has estimated the economic contribution of the Pukekohe hub's horticulture industry. The estimate provides a snapshot of the economic footprint of horticulture and related value-adding activities in the hub throughout the regional economy.

There are two parts to the economic contribution of the hub's horticulture industry; its direct contribution and its indirect contribution.

### Direct contribution

Horticulture in the Pukekohe hub is a wealth-creating industry, both from a business and personal income perspective, which is reflected in the direct economic contribution. Direct economic contribution captures the economic activity of horticulture growing and processing in the hub itself, and is measured as the value added by the activities of businesses (i.e. the sum of returns to labour and capital) within that industry.

### Indirect contribution

The industry also supports wider business activity and service industries within the hub, reflected in the indirect economic contribution. Indirect economic contribution captures the flow-on effects of the industry's expenditure on intermediate inputs, and is measured using Input-Output ('IO') modelling. The linkages and interdependencies between various sectors of an economy are used to analyse the inputs that represent final demand and which flow to other sectors as inputs. Deloitte constructed a regional IO model based on Statistics New Zealand IO tables to estimate the indirect value added, based on data provided by horticulture growers and distributors in the Pukekohe hub.

Further detail on the methodology can be found in Appendix A.

The total economic contribution of the Pukekohe hub's horticulture industry to the hub is estimated to be \$261 million per annum (in 2017 dollars, see Table 1). This represents 0.3% of the Auckland regional economy.

This total contribution can be split into two distinct categories; direct and indirect contribution of the horticulture industry:

- The hub's horticulture industry directly contributes approximately \$86 million per annum in value-added terms to the regional economy
- The hub's horticulture industry indirect contribution, reflecting expenditure on intermediate inputs (such as agricultural support services, water, machinery, feed, fertiliser and seed), is approximately \$175 million per annum in value-added terms

Table 1: Total economic contribution of horticulture growing and processing to the Auckland and Waikato District regions' economy, 2016-17 (\$ millions)

	Direct	Indirect	Total
Value added	86	175	261
- Labour income	62	87	149
- Gross operating surplus	24	88	112

Source: Deloitte Access Economics

The direct contribution of the Pukekohe hub's horticulture comprises \$62 million in wages and \$24 million in gross operating surpluses. The total direct contribution is only 26% of the total revenue of \$327 million earned by growers in the Pukekohe hub. Typically, in economic modelling, direct contribution of an industry will be closer to 50% of revenue, and this relatively low proportion is indicative of a competitive industry, and low margins faced by growers.

The indirect contribution is \$175 million. This illustrates the hub's significant role in supporting activity in other parts of the regional economy, and that its indirect contribution is twice as high as the direct economic contribution. The indirect economic contribution emphasises the value of the hub's horticulture to the regional economy, and it shows the raft of economic spillover effects affecting other linked industries related to horticulture.

For example, the hub's horticulture industry draws on inputs from a wide range of ancillary industries. In this way, the hub also supports wider business activity and service industries within the Pukekohe area. The top ten industries that benefited from the hub's horticulture industry's purchases are shown below. The top ten industries comprised 52% of the total indirect economic contribution.

Table 2: The top industries that benefit from the Pukekohe hub's horticulture industry's purchases

Industry	\$ millions
Agriculture support services	25.7
Building cleaning, pest control, and other support services	9.3
Non-residential property operation	9.0
Banking and financing and financial asset investing	8.5
Warehousing and storage services	8.0
Repair and maintenance	7.7
Fertiliser and pesticide manufacturing	6.6
Road transport	6.5
Legal and accounting services	5.3
Labour contractors and other administrative services	5.3

Source: Deloitte Access Economics



Agriculture support services receives the most spill over, gaining \$25.7 million (15%) of the hub's horticulture indirect contribution to the regional economy, followed by building cleaning, pest control, and other support services at \$9.3 million, and non-residential property operation at \$9 million. Employment and other administrative services is one of the top ten industries from which the hub's horticulture draws its inputs, reflecting the tendency of growers to hire labour contractors for seasonal workers.

However growth in the Pukekohe hub's horticulture industry is potentially constrained  
Yet rising land values in the Pukekohe hub are pushing growers to invest elsewhere as a means to facilitate growth, diversify risk and as a direct result of the unaffordability of current land in the hub. While not necessarily bad for the industry, this is a direct constraint to the growth, distribution and sustainability of the hub's financial capital.

The squeeze on available land within the Pukekohe hub has meant that a number of growers are spreading their operations into the Matamata-Piako District, the future of which may become more uncertain given increased regulation. The Waikato Regional Council's Proposed Plan Change 1 considers a land use change to new commercial vegetable growing as a non-complying activity, where currently it is a permitted activity.<sup>35</sup> This Plan Change, although currently in place, is still going through a consultation process, with over 1,000 submissions to date, and may be subject to change. As part of the proposed resource consent, a Nitrogen Reference Point will need to be established. The Nitrogen Reference Point is proposed to be tied to the land parcel and cannot be exceeded. If this proposed requirement becomes operative, it will limit the flexibility of vegetable rotations and the ability of other landowners to lease land to growers.

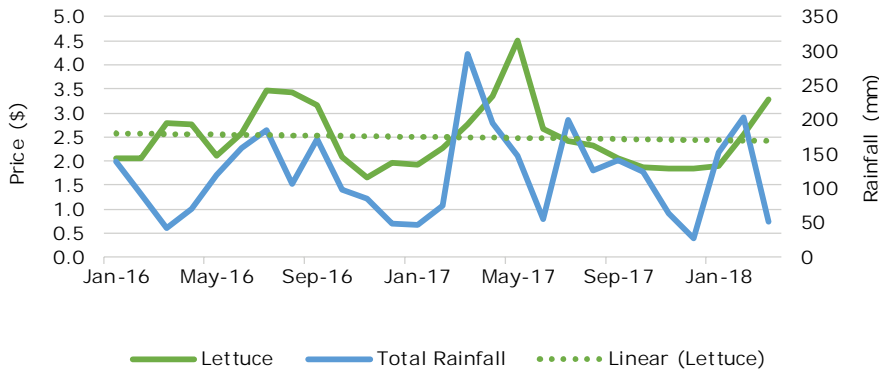
Low margins and return on capital is a continuing challenge for the industry  
Like many others who have worked the land before them, cropping is in growers' blood – it's what they do. Yet from a financial perspective, growers have increasing concerns over low margins and low returns on productive land. John Sutherland of Sutherland Produce says, "there are diminishing returns as the efficiencies gained in the last 10 years have been slower than in the previous 10 – overall profit margins are continually decreasing." Institutionalised low returns, coupled with more frequent, extreme weather events, significantly affects growers' yields, earnings, and the ability to contribute to the area's financial capital.

Weather conditions also affect the growth of fruit and vegetables, sometimes resulting in a surplus or shortage and attendant price fluctuations. The graph below compares the nominal price of lettuce and rainfall over the past two years, showing a relatively strong correlation between the two.

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<sup>35</sup> Waikato Regional Council, Summary of the proposed rules, (Proposed Waikato Regional Plan Change 1), <<https://www.waikatoregion.govt.nz/assets/WRC/Council/Policy-and-Plans/HR/FAQS/5946-HRWO-Factsheets-2018-Summary-of-rules-DR.pdf>>

Figure 9: Comparison of nominal lettuce prices and rainfall (2016 to 2018)



Source: NIWA Data and Deloitte Analysis based on Weekly Retail Prices

The Pukekohe hub is a key part of New Zealand horticulture's wider supply chain

Growing is a key part of the wider horticulture supply chain and the industry has made substantial investments in land, plant, technology, freight and other physical assets to support itself. Brigit Corson of Foodstuffs confirmed the importance of the hub within the supply chain: "the closer you are to the origin of the produce, the better, because freshness is not compromised."

The hub's location is another essential aspect to maintaining growers' margins. The low price and larger volume of vegetables, compared to fruit, such as apples, makes freight a significant cost for growers – not only in an absolute sense but also relative to the price of the vegetable. Being close to markets, transport and ports is therefore critical.

### Human capital

#### Food for physical health

The Ministry of Health recommends that New Zealand adults eat at least three servings of vegetables and two servings of fruit each day. According to the most recent New Zealand Health Survey:

- 62% of adults meet the minimum vegetable intake requirement, although less than half of Asian and Pasifika adults meet this guideline
- Average vegetable consumption is greater than average fruit consumption
- Only 38.8% of people meet the recommended vegetable and fruit intake guidelines, with Asian, Maori and Pasifika people, and those living in the most deprived neighbourhoods, least likely to meet the guideline<sup>36</sup>

There is a well-established link between an increased intake of vegetables and improved health outcomes. Health and wellbeing is essential to people's ability to function and thrive. "You are what you eat" is a well-known adage,

<sup>36</sup> [https://minhealthnz.shinyapps.io/nz-health-survey-2016-17-annual-data-explorer/\\_w\\_e9a07e83/\\_w\\_aa03fb73/\\_w\\_2a414f1e/\\_w\\_f041240b/#!/explore-indicators](https://minhealthnz.shinyapps.io/nz-health-survey-2016-17-annual-data-explorer/_w_e9a07e83/_w_aa03fb73/_w_2a414f1e/_w_f041240b/#!/explore-indicators)

which is increasingly supported by evidence linking healthy diets to optimal physical and mental health.<sup>37,38</sup> Studies undertaken within New Zealand prove the relationship between healthy food and wellbeing. For example, the University of Otago found that those consuming additional fruit and vegetables experienced physiological benefits, including increased vitality and motivation during the trial period.<sup>39</sup>

The industry's contribution to human capital goes beyond diet and nutrition.

The industry is a vital source of direct and indirect employment. In a world where automation is replacing jobs faster than new jobs are created, the Pukekohe hub's horticulture industry provides essential access to a source of sustained employment at the lower end of the skills ladder. A local industry, where significant travel is not required, also provides options for a sustainable second income for many households in the area that might not otherwise be available.

The total employment from Pukekohe's horticulture hub is 3,090 FTE roles. This total contribution can be split into two distinct categories; direct contribution and indirect contribution of the horticulture industry:

- The hub's horticulture industry directly contributes 1,458 FTEs to the region
- The hub's horticulture industry's indirect contribution, reflecting employment created within intermediate industries, is 1,632 FTEs to the region

During 2017, there were 6,700 FTEs employed in the growing of vegetables, both under cover and outdoors in New Zealand. Within the Pukekohe hub, 1,458 FTEs are currently employed. This accounts for a relatively large share (22%) of total vegetable growing employment in New Zealand, reflecting the importance of Pukekohe as a growing hub.

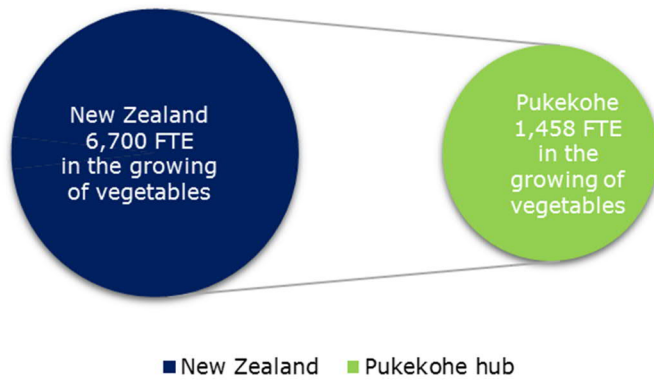
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<sup>37</sup> Rooney C., McKinley M. C., Woodside J. V. (2013), The potential role of fruit and vegetables in aspects of psychological well-being: a review of the literature and future directions, <<https://www.ncbi.nlm.nih.gov/pubmed/24020691>>

<sup>38</sup> Robberecht H., De Bruyne T., Hermans N. (2017), Effect of various diets on biomarkers of the metabolic syndrome, <<https://www.ncbi.nlm.nih.gov/pubmed/2802769>>

<sup>39</sup> Conner TS, Brookie KL, Carr AC, Mainvil LA, Vissers MCM (2017), Let them eat fruit! The effect of fruit and vegetable consumption on psychological well-being in young adults: A randomized controlled trial, <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5291486/>>

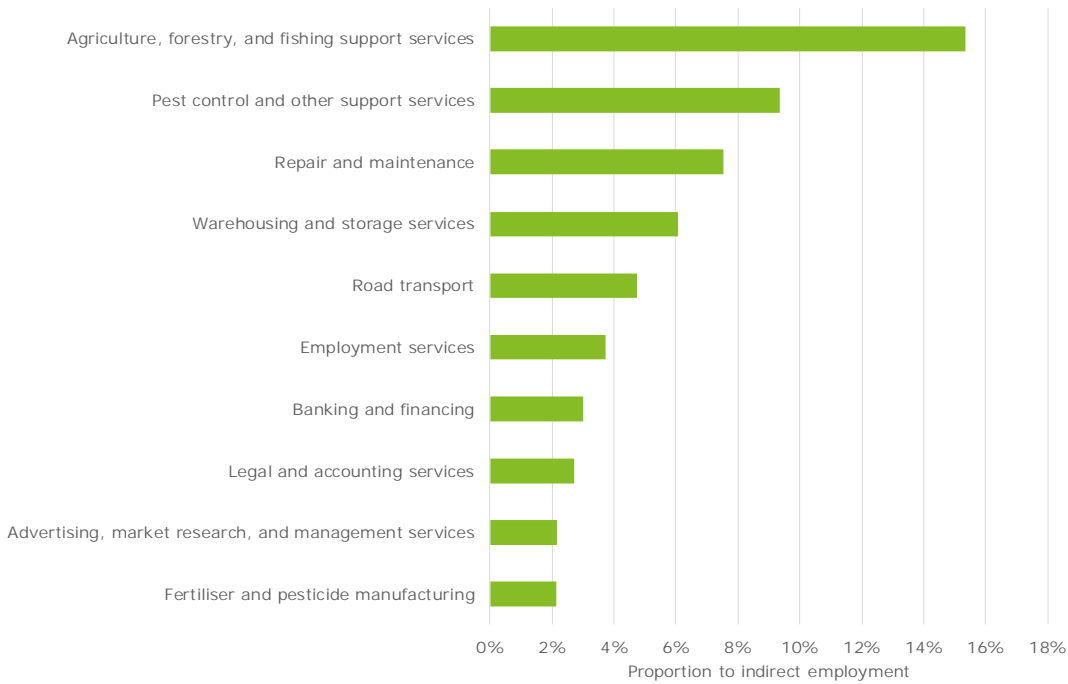
Figure 10: Contribution of indirect employment by industry



Source: Deloitte

Over 1,600 FTE jobs are created in industries that provide services to the Pukekohe horticulture hub. In particular, the indirect contribution of Pukekohe's horticulture industry includes 1,632 FTEs employed in sectors providing inputs into the horticulture sector. The top ten industries benefiting from employment as a result of purchases from the Pukekohe hub's horticulture industry are shown in Figure 11. The employment in these top ten industries comprised 57% of the total indirect employment.

Figure 11: Indirect employment to the top ten industries from the Pukekohe hub's horticulture industry's purchases



Source: Deloitte

Yet challenges remain in sourcing labour and promoting the industry as a viable career path

Despite employing the equivalent of 3,090 FTEs, the industry is challenged with an undersupply of labour, both skilled labour and intensive labour required during the seasonal peaks. Growers have had to become creative in sourcing labour, including bussing in people from Auckland, undertaking exchange programmes with various countries in the Pacific and the UK, and using the Recognised Seasonal Employer ('RSE') scheme, which allows growers to recruit workers from the Pacific Island countries when sourcing local labour is difficult.

Growers feel the lack of skilled talent coming into the industry is one of the biggest threats to the hub's future. Growers believe the industry could be better promoted as a viable career path for those who might be academically inclined to related disciplines, including agronomy and science, rather than being pigeon-holed as an industry requiring few skills and offering limited prospects.

In response, many growers are beginning to engage with education providers, such as Pukekohe High School, Massey and Lincoln Universities and the Primary ITO, to promote the industry and develop unique, horticulture-specific industry courses to encourage more human capital into the industry. The PVGA makes a point of attending local high school career evenings to shift perceptions among teachers, parents and students.

Succession planning is a key concern for the industry. Finally, a theme not unusual to primary industries, and specific to human capital, is a concern around the succession planning for these legacy horticulture businesses. The rising cost of land, the increasing urban disconnect and lack of skilled talent coming into the industry has created a potential succession planning risk to New Zealand's food security, given the technical nature of the industry and efficiencies required to make a return on investment.

### Social capital

Intergenerational employment and legacy businesses create social stability

The contributions of the hub's legacy horticulture businesses to the area's social fabric is palpable. These businesses have supported intergenerational employment, created in-demand employment in some areas, and enhanced the social stability of the Pukekohe hub. Pravin and Kiran Hari of RC Hari & Sons say that "Pukekohe [town] has been a farming town for a long time. We went to Pukekohe High and most of our classmate's families were connected to horticulture in some way."

The workforce within the hub's horticulture industry was described as multicultural, reflecting the changing demographics of New Zealand, with Rob Craig of Punchbowl Investments reflecting that their business makes a point of "keeping cultural diversity within their labour force." A 2014, IZA World of Labour study found that 'super diversity' in a region – i.e. a

significant increase in minority ethnic and immigrant groups – can provide higher levels of innovation and work productivity.<sup>40</sup>

The importance of social cohesion and its effects on wellbeing have been studied and documented in numerous literature reviews, including the findings of a strong link between a positive social environment and wellbeing, in the form of household income and economic growth.<sup>41</sup>

However, the intensification of urban sprawl within the hub is causing concern among some growers, who feel growth is weakening the area's social fabric and diluting the small-town, community feel.

"The current developments in villages/country communities are viable – but there is a limit to the development these towns can sustain to still keep the village atmosphere," says Rob Craig.

With changing demographics, there are increasing concerns over reverse sensitivities

Rapid social change, like in growth areas such as the Pukekohe hub, can create social disharmony between newly arrived groups and established communities.<sup>42</sup> In the hub's context, a lack of social cohesion and connection can heighten the issue of reverse sensitivities and make cropping on current rural-zoned land more difficult to manage.

"We've recently got rid of some land on the outskirts of town," says Bharat Jivan. "It was just getting too hard to farm."

The burgeoning population means there are more neighbours to consult and inform when undertaking activities like spreading fertiliser – and not all of those neighbours were tolerant of such activities. Growers are calling for careful planning around land use and 'buffers' within new residential zones, or developments to maintain adequate separation between residential housing and horticulture operations.

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<sup>40</sup> Paul Spoonley, (2014), Superdiversity, social cohesion, and economic benefits, <<https://wol.iza.org/articles/superdiversity-social-cohesion-and-economic-benefits/long>>

<sup>41</sup> Knack and Keefer (1997), Does Social Capital Have an Economic Payoff? A Cross-Country Investigation, <<https://academic.oup.com/qje/article-abstract/112/4/1251/1911732?redirectedFrom=fulltext>>; Zak and Knack 2001, Trust and Growth, <<https://onlinelibrary.wiley.com/doi/abs/10.1111/1468-0297.00609>>; Narayan and Pritchett (1999), Cents and Sociability: Household Income and Social Capital in Rural Tanzania, <<https://www.isid.ac.in/~tridip/Teaching/DevelopmentMicroeconomics/Readings/Narayan&Pritchett-EcoDevCulturalChange-1999.pdf>>; Grootaert (2001), Understanding and measuring social capital: A synthesis of findings and recommendations from the Social Capital Initiative, <<http://siteresources.worldbank.org/INTSOCIALCAPITAL/Resources/Social-Capital-Initiative-Working-Paper-Series/SCI-WPS-24.pdf>>; Tabellini (2005), Culture and Institutions: Economic Development in the Regions of Europe, <[https://ideas.repec.org/p/ces/ceswps/\\_1492.html](https://ideas.repec.org/p/ces/ceswps/_1492.html)>; Knowles and Weatherston (2007), The Impact of Formal and Informal Institutions on Per Capita Income, <<http://opus.uni-hohenheim.de/volltexte/2010/414/pdf/319.pdf>>

<sup>42</sup> Australian Human Rights Commission, Building a social cohesion in our communities, <[https://www.humanrights.gov.au/sites/default/files/document/publication/WEB\\_Building\\_social\\_cohesion\\_A4\\_brochure.pdf](https://www.humanrights.gov.au/sites/default/files/document/publication/WEB_Building_social_cohesion_A4_brochure.pdf)>

## The issue of reverse sensitivities

Reverse sensitivity, a term from the New Zealand planning system, is a concept that refers to the vulnerability of an established land use (for example, cropping) to complaints (legal or otherwise) from a newly established, more sensitive land use (such as residential and other noise-sensitive activities).

Reverse sensitivities often arise as urban sprawl and cropping intensification create land use conflicts. In practice, complaints from neighbours can compromise the established land use by restricting when or how it can operate, or by imposing economic burdens that reduce their viability.

Reverse sensitivities are best addressed during planning, and need to be managed to allow for existing land use to operate as intended, while appreciating the desire for neighbouring land owners to enjoy their property free from interference or nuisance.

The horticulture industry creates, and contributes significantly, to vibrant businesses and communities

The horticulture industry in the Pukekohe hub supports service businesses and communities that might not have been there if not for the industry. Growers commented on having strong relationships with their local suppliers, despite the availability of potentially cheaper sources. John Sutherland has at times paid more to support a local business as for him "it's not just about the dollar value of services – it's about the relationship with people."

The industry contributes significantly to local fundraising, sponsorship, and events such as school calf club days. They also donate produce to tangi and other events at local marae.

"Giving back to the community is part of the social license that allows businesses like ours to operate," says Dacey Balle.

Growers' involvement with sports clubs and teams runs long and deep. The Pukekohe Indian Sports Club was formed near the end of World War II, and local growers to this day are still involved. Others sponsor the Blues or the Steelers.

"Often growers are time-poor," says Dacey Balle. "If they can't be at the sports club coaching on weeknights or at the game on the weekend, they contribute in other ways."

# Economic impact of constraining horticulture production in the Pukekohe hub

## Summary of the impact of future production constraints

To understand the economic impact of long term trends experienced by the Pukekohe hub, Deloitte Access Economics undertook economic modelling based on two future scenarios: a base case scenario and a constrained 'counterfactual' scenario. Each scenario is modelled over Auckland and the Waikato District over 25 years, out to 2043. As the bulk of the hub's produce goes to Auckland, the impact is broadly referred to as the impact on the Auckland economy, though it is likely some of the economic losses will be felt in the Waikato District.

Under both the counterfactual and base case scenarios, demand for fruit and vegetables, and Auckland's population, are projected to grow significantly. The need for growers to operate efficiently, meet nutritional needs of their customers, and contribute to economic prosperity, remains.

### Base case scenario

If the hub can manage future land challenges and other threats to production effectively, it will match Auckland's expected cumulative annual demand growth of 1.2% for fruit and vegetables through to 2043. By 2043 demand will be 33% higher than it is in 2018 - slightly below population growth, as not everyone will consume the same amount of fruit and vegetables. The demand modelled does not provide for the increase in vegetable and fruit consumption required for all Aucklanders to meet the Ministry of Health nutrition guidelines.

Under the base case, the horticulture industry operates under production constraints, but they are managed effectively. As it grows to match Auckland's demand, the value of fruit and vegetable production in the hub will grow 39% over 25 years.

### Constrained (counterfactual) scenario

On the other hand, an inability to manage future constraints effectively will lead to higher consumer prices and reduced economic activity.

In the counterfactual, production is constrained compared to the base case, as the industry is unable to afford new land, and access to existing land is threatened. Land scarcity and access challenges could arise in the future due to urban encroachment, water access issues, a biosecurity risk, changes in land use regulation or a combination of these. The impact of land scarcity could be amplified by a lack of skilled labour or lack of productivity growth.



Two variations of the counterfactual scenario have also been considered in the form of sensitivities, as follows:

- Flexible – Where growers have the ability to change their practices and input mix in response to land access and other constraints on production
- Rigid – Where land scarcity is further constrained by land use restrictions

Deloitte would expect the counterfactual scenario to lie in the middle of the flexible sensitivity and the rigid sensitivity.

Out of the two sensitivities, Deloitte considers the rigid variation more likely to occur. This is because growers’ ability to respond to production constraints more likely to be limited by environmental constraints, external regulations - like new taxes or land-use restrictions - or limited access to capital that could support alternative growing methods. For this reason, the summary table, Table 3, reports the economic impact results for the counterfactual and rigid sensitivities.

If horticulture production is constrained, and growers’ ability to respond to production constraints is limited, the estimated economic impact is as follows:

Table 3: The economic impact of constraining horticulture production over 25 years, 2018 to 2043

	Counterfactual relative to the base case	Rigid sensitivity relative to the base case
Impact on regional GDP (\$, today's value terms)	\$850 million	\$1.1 billion
Impact on regional employment by 2043 (FTEs)	3,500	4,500
Loss in output volume (%)	46%	55%
Higher prices (%)	43%	58%

Source: Deloitte Access Economics

## Auckland's growing demand for fruit and vegetables

The population of Auckland is expected to be 37% higher in 2043 compared to 2018.<sup>43</sup> As international studies show, as population grows, so too does the demand growth for fruit and vegetables.

The modelling assumes forecast economic growth of 2% year on year. This is also expected to underpin demand for fruit and vegetables through to 2043, as household incomes grow, driving some increase in the amount of fruit and vegetables households buy.

The modelling predicts that Auckland will see cumulative annual demand growth of 1.2% for vegetables through to 2043. By 2043, demand will be 33% higher than it is in 2018.

As Auckland's population grows through to 2043, the importance of the horticulture industry to meeting New Zealanders' dietary needs and its contribution to the nation's economic prosperity will remain.

However, population growth will also mean that the Pukekohe region will increasingly need to compete with alternate uses of land. Alongside land access challenges, the horticulture industry may also need to address other threats to production, such as biosecurity risks, urban encroachment, availability of skilled labour and water access issues, to ensure fruit and vegetable supply keeps up with growing regional demand.

If the Pukekohe region can manage future land challenges and other threats to production effectively, then it is expected to be able to meet the demands of a hungrier Auckland into the future, contributing not only to consumer welfare but also broader economic growth across the country. On the contrary, an inability to manage future constraints will lead to higher consumer prices and reduced economic activity.

## Effect of constraints on horticulture production

Land is one of the main inputs required to grow fruit and vegetables. As competition for land grows, the price of land will increase. With a fixed supply of land available, increased demand for land can lead to rapid property price rises.

This could lead to two outcomes:

1. If growers are unable to afford these price rises, they may not be able to increase production by purchasing new farms or expanding existing ones
2. Increased competition for land and the potential for conflicting uses may lead to restrictions on agricultural practices that could threaten access and use of existing land

Both of these constraints could limit the extent to which the horticulture industry can expand and produce more fruits and vegetables.

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<sup>43</sup> Stats NZ, Subnational Population Projections, <[http://archive.stats.govt.nz/browse\\_for\\_stats/population/estimates\\_and\\_projections/subnational-population-projections-info-releases.aspx](http://archive.stats.govt.nz/browse_for_stats/population/estimates_and_projections/subnational-population-projections-info-releases.aspx)>

In the model, Deloitte Access Economics restricted land access to estimate the impact of a constraint on horticulture production. Similarly, other challenges could have the same constraining effect on horticulture production.

The impact of constraining horticulture production is twofold:

- Consumers face reduced supply, which leads to higher prices for fruit and vegetables. This could also result in shortages and / or imports from other regions of New Zealand (or potentially from overseas) to substitute the supply gap
- Economic activity contracts, primarily in horticulture, but also in other sectors supplying the industry and beyond. Therefore, this reduced economic activity, in effect, flows through to the rest of the economy

# The Pukekohe hub

## Economic impact

2018

25 years

2043

By **2043**  
Auckland's population will be



which is a  
**37%**  
increase on 2018

By **2043**  
Auckland's demand will be

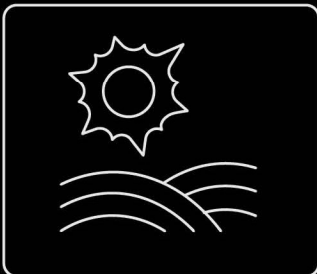


As it grows  
to match  
Auckland's  
demand,  
the value  
of production  
of fruit and  
vegetables  
within the  
hub will grow

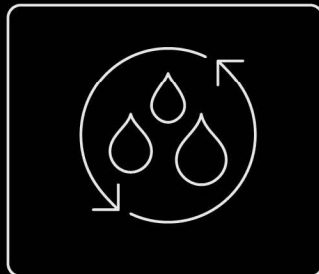


## But there are constraints stopping the hub reaching its potential

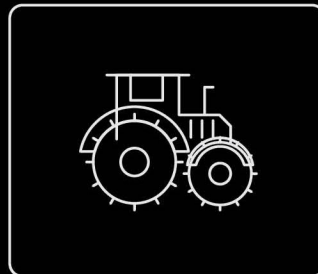
### Competition for land



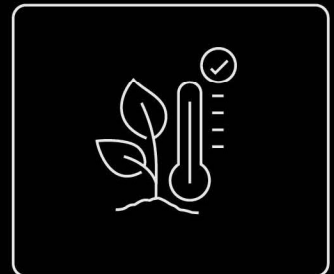
### Water access



### Labour and technology



### Crop protection and nutrition



If growers' ability to respond to production is constrained, it is estimated that Auckland's economy will face over the next 25 years:

An economic hit of between

**\$850 – \$1.1**  
million billion

in today's dollar terms

The loss of between

**3,500 – 4,500**  
FTEs



Decrease in fruit and vegetable  
production volume of between

**46% – 55%**



Price rises of between

**43% – 58%**

A lettuce that is \$3.50 in the base case could be

**\$5.01 – \$5.54**



## Scenario development

To understand the economic impact of land constraints on horticultural production in the Pukekohe hub, Deloitte Access Economics compare a 'base case' (where production will continue to grow to meet increasing regional demand) to an alternative scenario (where horticulture production is constrained and cannot meet increased demand over the next 25 years). In particular:

- The 'base case' reflects a future path of the economy continuing as it has in the past. While the horticulture industry is expected to face some challenges in accessing land, it is expected to be able to manage these, and production continues to grow to meet the demands of Auckland's expanding population. The base case scenario can be thought of as a measure of the future productive potential of the hub's horticulture industry through to 2043, without land or production constraints.
- The alternative or 'counterfactual' scenario reflects a future where production of horticulture is constrained, as growers are unable to afford new land, and access to existing land is threatened. Land scarcity and access challenges could arise in future due to urban encroachment, water access issues, a biosecurity risk, changes in land use regulation or a combination of these. The impact of land scarcity could be amplified by a lack of skilled labour or sluggish growth.

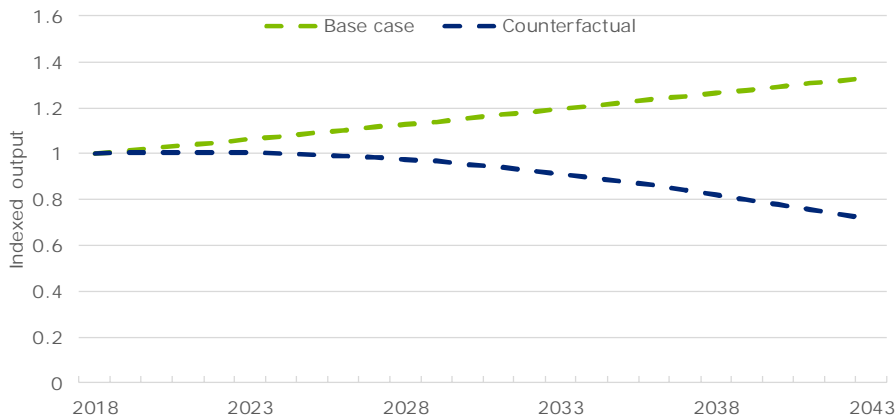
## Model inputs

Under both the base case and counterfactual scenarios, regional demand for fruit and vegetables, and Auckland's population, grow significantly. However, in the counterfactual, the horticulture industry's production is constrained. The impact of this constraint on production is:

- The industry only has access to existing horticulture land, and fruit and vegetable growing intensifies
- The horticulture industry loses access to more land as competing industries outbid horticulture for land, limiting future production of fruit and vegetables. In short, growers cannot afford to expand production to new land
- Other land use restrictions are introduced as land use diversifies and conflicts increase, threatening existing and future horticulture production

Under the base case scenario, the Pukekohe hub will grow by 1.2% each year over 25 years to match Auckland's demand for vegetables. The effect of the constraining factors will result in the volume of production being 46% lower in 2043 under the counterfactual than it would be under the base case.

Figure 12: Annual output (indexed to 1)



Source: Deloitte Access Economics

In the counterfactual scenario, horticulture does not use land, capital or labour any differently to the base case. In other words, both projections of the future will have access to the same capital improvements and labour markets. The only difference between the two is that land access challenges limit the ability of the industry to grow fruit and vegetables, so output is constrained.

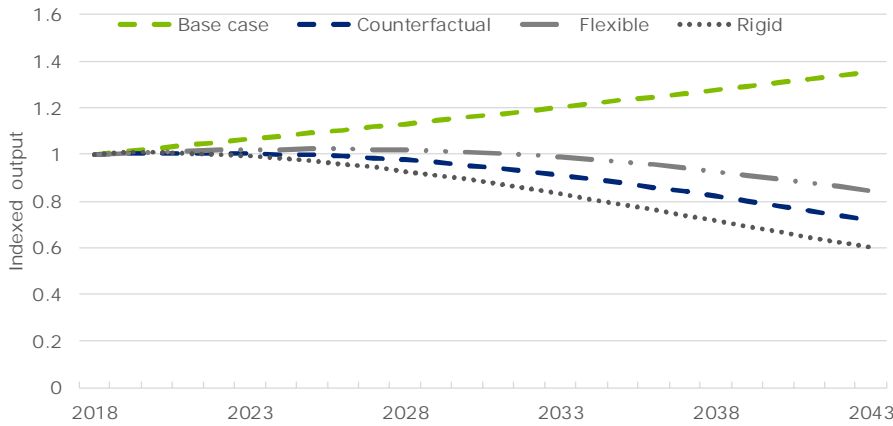
In reality, there are many other possibilities that could eventuate from land use constraints. Two other possible outcomes were considered:

1. Growers change farming practices in response to land use constraints. For example, they might change their operations to intensive production methods, like glasshouses or vertical farming, or may increase machinery or labour to crop more efficiently on their existing land
2. Growers face further constraints as land use restrictions are introduced due to conflicts with incoming land users, limiting the efficient use of existing machinery, labour or growing methods such as fertiliser and pesticides

In order to understand the impact of these possibilities, the modelling considers the economic impact of land use constraints under each of these alternative 'sensitivities' compared to base case. Two sensitivities were specifically modelled:

- Flexible: Growers change farming practices in response to land constraints. Under the flexible assumption, fruit and vegetable volume of production is expected to be 38% lower than forecast under the base case by 2043, compared to the counterfactual of 46% lower than the base case
- Rigid: Land scarcity is further constrained by land use restrictions. Under the rigid assumption, volume of production of fruit and vegetables is expected to be 55% lower than forecast under the base case in 2043, again compared to the counterfactual of 46% lower than the base case

Figure 13 Annual output (indexed to 1) of the flexible and rigid sensitivities



Source: Deloitte

Of the two sensitivities, Deloitte considers that the rigid variation more likely to occur. This is because growers’ ability to respond to production constraints could be limited by environmental constraints, external regulations such as the recent implementation of a regional fuel tax, changes in land use regulation in the Waikato, and limited access to capital that could support alternative cropping methods.

### Model methodology

Both the base case and counterfactual scenario are modelled using the Deloitte Access Economics regional general equilibrium model (‘DAE-RGEM’). The differences in economic outcomes under each scenario constitute the economic impact of the production constraint.

DAE-RGEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium (‘CGE’) model of the world economy, with bottom-up modelling of New Zealand’s regions. DAE-RGEM encompasses all economic activity in an economy, including production, consumption, employment, taxes and trade and the inter-linkages between them.

For this study, the DAE-RGEM has been customised to explicitly represent the Pukekohe horticulture hub and Auckland regional economy. This customisation takes into account the make-up of the Pukekohe hub and Auckland regional economies, and is based on employment data by industry and demand for intermediate inputs, which may be sourced locally or through intra-region or inter-region trade.

More detail on the modelling framework used is provided in Appendix B.

The impact of constraining horticulture production within the Pukekohe hub is expected to be felt most within Auckland, but impacts also extend to the broader New Zealand economy.

The following subsections present the total economic impact on consumer prices, gross domestic product (‘GDP’) and regional GDP, and the impact on employment.

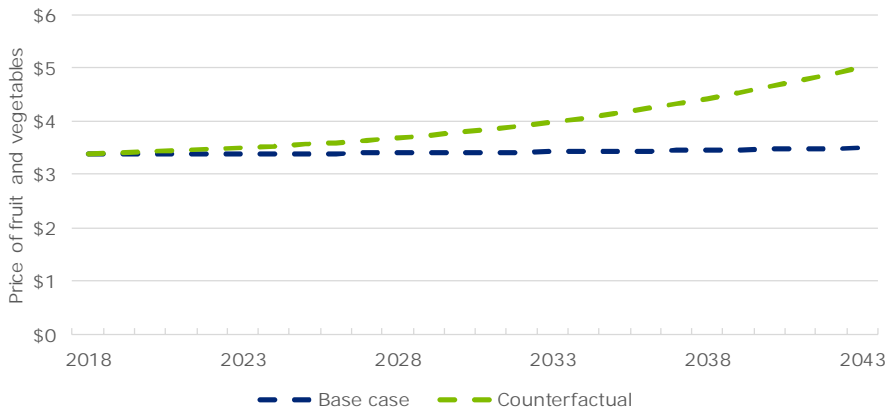
### Impact on consumer prices of the horticulture production constraint

The impact of the counterfactual scenario will be felt most heavily by consumers within the Auckland region. Prices for fruit and vegetables are forecast to be higher each year relative to base case.

Figure 14 shows that by 2043, it is estimated Aucklanders will face fruit and vegetable prices 43% higher than under the base case scenario. For example, if lettuce is \$3.50 in 2043 under base case, then lettuce is expected to be \$5.01 under the counterfactual in 2043. This increase is more significant under the rigid sensitivity; prices could be 58% higher by 2043 relative to the base case scenario.

The price of fruit and vegetables under base case is only expected to increase marginally as producers are able to continue meeting demand for fresh produce.

Figure 14: Price of fruit and vegetables per annum



Source: Deloitte

In order to afford all of their expenses in the 2043 counterfactual scenario, consumers will be faced with choices around their grocery bill:

- Faced with higher prices, they may choose to reduce the amount of fruit and vegetables they buy, potentially leading to poorer health outcomes
- Alternatively, consumers could choose to prioritise fruit and vegetables, but by doing so, decide not to purchase other goods. This change in consumption habits would lead to declining sales in other sectors, causing much wider economic effects than just those felt by the horticulture industry

Under the counterfactual, most demand in Auckland would be met by vegetables and fruit imports from other regions in New Zealand. This will amount to \$168 million in 2043, when the region's population is expected to be at its highest for the modelling period. With supply in the hub constrained, and produce having to travel further to Auckland from other parts of the country, Aucklanders could bear the brunt of increased freight costs and periodically feel the effects of supply shortages.



### Impact on regional GDP from the horticulture production constraint

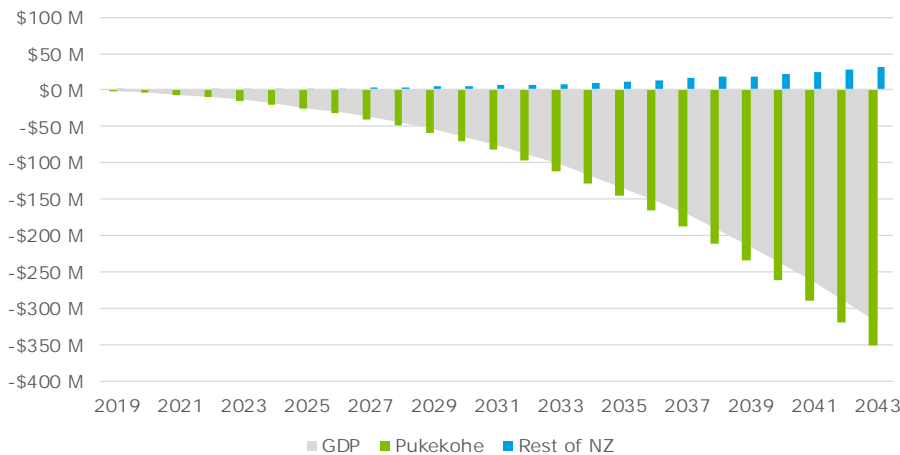
The regional GDP is expected to be \$850 million lower over the 25-year forecast period, in today’s dollar terms, than it otherwise would be under the base case scenario. Figure 15 below show the annual impact is expected to be highest at the end of the period, with the region’s population at its highest in 2043.

The rest of New Zealand is forecast to benefit slightly under the counterfactual relative to expectations for the economy, as the Auckland region imports more food from around the country. This benefit is estimated to net to \$70 million in today’s value over 25 years, compared to the base case.

However, these gains outside the region are not sufficient to offset the losses to the Pukekohe hub, and the total GDP impact on New Zealand’s economy is estimated to be GDP that is \$780 million lower in today’s dollar terms through to 2043.

Under the rigid assumption, where growers are further constrained in their ability to expand production, the total economic impact on the region is forecast to be even greater, at \$1.1 billion (over 25 years) less than the base case scenario. The total impact upon New Zealand’s economy under this rigid assumption is that GDP is estimated to be \$1 billion dollars lower than the base case scenario over the 25-year forecast period, with some slight gains to the rest of New Zealand’s economy moderating the country’s losses marginally.

Figure 15: Estimated annual impact to regional GDP through to 2043 (counterfactual)

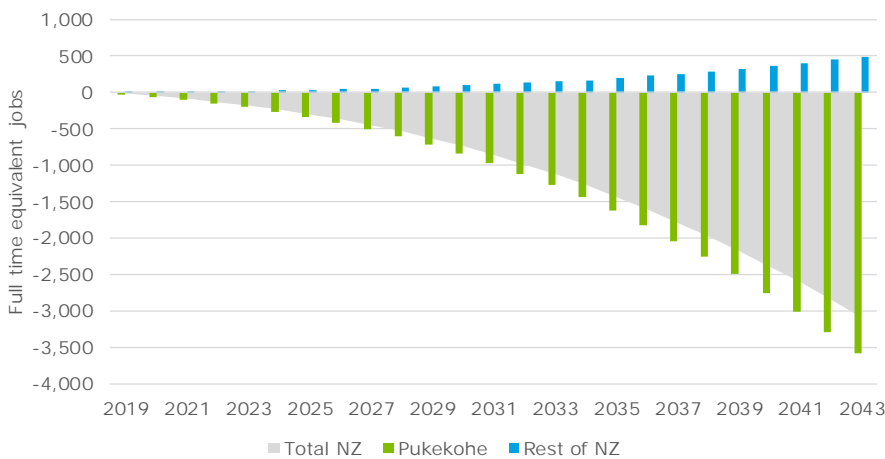


Source: Deloitte

### Impact on regional employment from the horticulture production constraint

Under the counterfactual, it is estimated there will be 3,500 fewer FTEs in the Pukekohe region by 2043 compared to the base case expectations. For the rest of New Zealand, employment is forecast to be slightly higher, with 489 additional FTEs in 2043 compared to the base case. However, on balance, the total New Zealand picture is job losses of around 3,000 FTEs by 2043.

Figure 16: Estimated annual employment impacts through to 2043



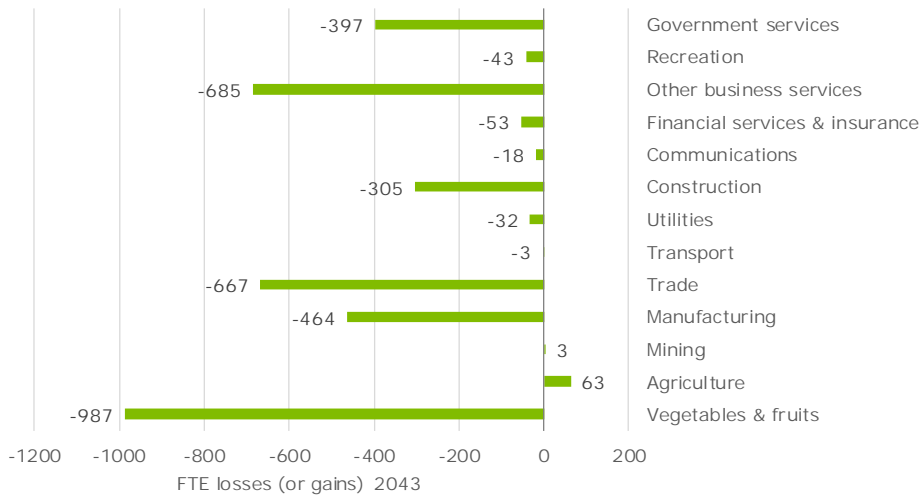
Source: Deloitte

Horticulture experiences the greatest number of job losses each year through to 2043. The highest job losses for horticulture are forecast to occur in 2043, with nearly 1,000 fewer FTEs compared to base case. A decline in employment in other industries within the region is also forecast. For example:

- The trade sector is projected to have 667 fewer FTEs in 2043
- Other business services are expected to see a reduction in FTEs of 685 by 2043
- The construction industry is expected to have 305 fewer FTEs in 2043

Job losses in other industries illustrate the flow-on effects that production constraints will have through the economy. Industries that process or sell fruit and vegetables will be impacted directly, while other industries will be indirectly affected as Auckland's economy contracts, leaving workers and businesses with less income and profits.

Figure 17: FTE losses 2043 — counterfactual compared to base case



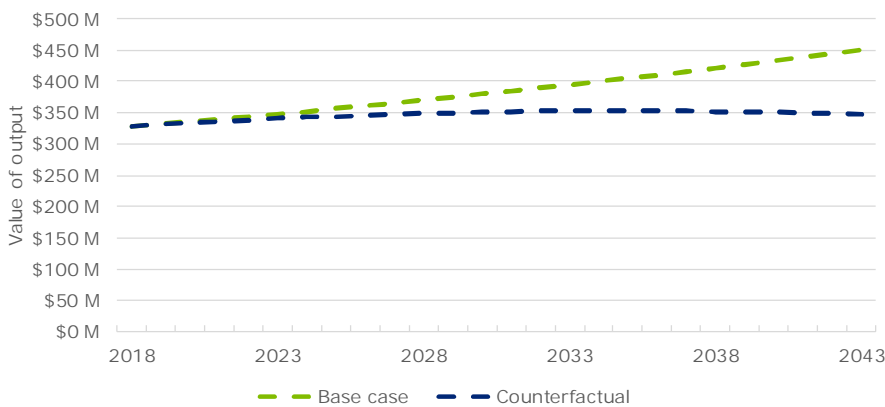
Source: Deloitte

### Impact on the value of output from the horticulture production constraint

The total value of fruit and vegetables is forecast to only marginally increase over the 25-year period under the counterfactual. While prices are forecast to rise, supporting an increase in total value, the total volume of output is constrained.

Under the counterfactual, the value of Pukekohe’s fruit and vegetable production would be 6.5% higher than it is in 2018, whereas under the base case, the total value of production would have grown 39%.

Figure 18: Value of output (fruit and vegetables)



Source: Deloitte

If the Pukekohe hub can continue to address land access challenges and other threats to production into the future, the industry should be able to keep up with demand for fruit and vegetables from a hungrier Auckland, contributing not only to health and wellbeing, but also to broader economic growth. But if the industry struggles to manage future land and production constraints, then Aucklanders are expected to face higher prices and economic activity in the region is expected to be lower.

# Looking to the future

So where to from here for the Pukekohe hub? The hub is an ecosystem that contributes both economically and socially, and touches on many facets of our communities, people and environment. But this ecosystem is under pressure.

Recent urban encroachment has garnered strong views on the protection of versatile land within the hub, and raised concerns around New Zealand's lack of a domestic food security plan.

## A National Policy Statement for 'elite' soils

The rapid urban sprawl in Pukekohe town was dramatic enough to prompt Environment Minister David Parker to direct officials to begin working on a NPS for Versatile Land and High Class Soils.<sup>44</sup> The purpose of the policy was described as a tool to provide guidance to ensure New Zealand can achieve both urban growth and adequate primary production. "We have to ensure we have enough land to build the houses people need" says Minister Parker, "but we must protect our most productive areas too."<sup>45</sup>

The growers Deloitte spoke to generally agreed New Zealand needed to be smarter about its long-term planning, food security and domestic supply. However, there were a range of views from growers on whether or not a tool to protect their prime growing land was the right way to go about this.

The development of any policy tool needs careful consideration. An NPS would have to be a nationwide discussion, with the acknowledgement that addressing unique regional aspects would be undertaken at a local level. "The process will take time," says Dacey Balle. "The NPS on Freshwater took years to develop, and we should be just as cautious now, so the Government can canvass the views of all concerned, not just the most vocal."

To add further complexity, it is acknowledged an elite soils NPS could create unintended commercial outcomes, in regards to land values, and impact on grower flexibility and succession planning. Rising land values are many growers' main form of return on investment and exit strategy, and there is a natural tension between subdivision and retaining the land for growing.

While strongly supportive of a NPS, Kevin Wilcox of A S Wilcox & Sons says it is a quandary for growers. "Their equity value is in their land and a NPS could decrease land values, but there is a need for growing with good productive land."

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<sup>44</sup> Stuff, Urban expansion gobbling up some of New Zealand's most versatile land, <<https://www.beehive.govt.nz/release/environment-report-highlights-serious-land-issues>>

<sup>45</sup> Stuff, Urban expansion gobbling up some of New Zealand's most versatile land, <<https://www.beehive.govt.nz/release/environment-report-highlights-serious-land-issues>>

This was tempered by the views of some growers who felt the involvement of the industry in developing an NPS would avoid this. "It's not about me and my succession," says Bharat Jivan. "It's about having land available to grow food for society which is more important – we're only here for a short time."

### An NPS as a tool for food security

Ultimately, this great natural system is being transformed, and there is a loss of growing land. This has prompted an increasing number of growers to raise their concerns at New Zealand's lack of a food security plan, particularly if there are restrictions on importing vegetables, such as leafy greens, into New Zealand for biosecurity reasons.

Bharat Jivan felt New Zealand was too blasé about domestic food security, given the current global political stability, and that "we shouldn't be short-sighted with this."

A 2010 report from Australia's Prime Minister's Science, Engineering and Innovation Council, recognised that food security is an issue for Australia, and outlined a national approach to food security.<sup>46</sup> Food security is also a key priority for the UK, given Britain's recent exit from the European Union, with a focus on supply side measures such as increasing UK productivity and diversifying production planned.<sup>47</sup>

Closer to home, in 2016 the Ministry for Primary Industries engaged industry leaders in workshops to understand what challenges our primary industries might face in 2030. Actions coming out of these workshops focused on brand, new technology and innovation, collaboration and skills and expertise but lacked any scenario planning for food security.

An NPS on versatile land, which ensures land for primary production purposes, could be a useful first step in establishing New Zealand's domestic food security plan.

### Future growth in the hub

Given the constraints around availability of high quality land within the hub, future growth is going to be heavily dependent on the use of technology to achieve efficiencies and adopting innovation in new cultivars, within agreed environmental limits.

There have been significant technology leaps in the industry - for example precision farming and spray technology - and there are opportunities to make better use of current tools. The use of technology, such as GPS and machinery, is changing practices and resulting in better and more efficient ways of cultivation, but capital requirements remain a big constraint for some growers.

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<sup>46</sup> PMSEIC, Australia and Food Security in a Changing World, <[https://www.chiefscientist.gov.au/wp-content/uploads/FoodSecurity\\_web.pdf](https://www.chiefscientist.gov.au/wp-content/uploads/FoodSecurity_web.pdf)>

<sup>47</sup> UK House of Parliament

Further opportunities for technology and automation in packhouses remains a core focus for growers, not only from an efficiency and productivity perspective, but also from a health and safety outlook. Growers are continually on the lookout for processes where manual, unsafe labour can be removed and automated, particularly as physical work is less appealing to younger generations.

The integration of information technology into horticulture businesses, such as automated data entry, will become increasingly more important as growers look for ways to further improve business efficiency amongst stable or decreasing margins, and to meet consumer demands around sustainable practices, traceability and transparency. As the industry consolidates and becomes more commercial, the use of accounting and crop management packages, and cloud based services, will become the norm. However, limited connectivity is still an issue for some growers who are not able to use all available technologies.

There is significant scope for innovation in new cultivars in the industry, both from a demand and supply side. Research and development into market trends and new varieties to cater to changing consumer tastes and preferences is largely handled by nurseries and seed providers, with some growers investing in new seed varieties from overseas. Currently there is minimal innovation in vegetables, however this is no different to elsewhere in the world.

On the supply side, growers are increasingly interested in sourcing new varieties that can handle changing weather patterns, such as humidity, and provide stable yields. Innovation in plant density and disease management could also be game-changing going forward, especially as the industry gears up to become more intensive within environmental constraints.

## Sutherland Produce – talent will grow the next generation

In the archives of Sutherland Produce's Bombay offices rests some of Sarah Webster's early work – the logo she designed for her father's vegetable business, created in pastels and crayons when she was 16.

"John is very perceptive," says Sarah of her father and co-founder of Sutherland Produce, John Sutherland. "He knew I was creative before I went to art school, and he trusted me – with a lot of oversight from him."

Sarah, now Sutherland Produce's marketing lead and operations administrator, found her early handiwork recently. Little did she know that after starting her career as a graphic designer, she would come full circle, back to her family farm on Mill Road – and, even more remarkably, both her sisters did too.

Kylie Faulkner and Laura Wood, like Sarah, never felt any pressure to join the family business – cropping was their father's dream, not theirs. But after stints in the tourism industry and professional services respectively, they came back to Bombay – Kylie as head of compliance and Laura as financial controller.

It hasn't been an easy ride, says Laura. "We have to work harder to get people's respect – some think we've simply been handed roles in the business. Being a woman means we also have to gain the respect of men in the industry, too."

The sisters are involved in a local Women in Horticulture group, and Kylie is the Vice President of the Pukekohe Vegetable Growers Association, where she is part of a new generation of growers advocating for horticulture to be taken seriously as a career by parents, students and universities. She knows their future success will be defined by the quality of the team they build around them.

"This is a demanding job so people need passion. The industry is crying out for engineers, mechanics and scientists. We've been trying to hire a crop manager for two years now, but there's a real shortage of people with the right skills."

While the sisters agree there is no easy solution, they believe it's important to get children interested and engaged with produce and growing. "We spent many hours out on the tractor with Dad and walking crops at the weekends," says Kylie, "and we want today's children to understand where food comes from, and the importance of a healthy diet. We take seedlings into schools to help teach them, and we offer job opportunities in the school holidays to older ones. Parents need to come on board, too, so they realise there really are opportunities in this industry for their kids."

While growing broccoli, lettuce and silverbeet wasn't what Kylie, Sarah and Laura imagined they would use their university degrees for, they know their abilities are sustaining the business in challenging times.

"Horticulture feels like a tough game," says John. "Costs have risen dramatically even after efficiencies have been achieved, but sales prices remain broadly flat."

"The next generation taking an interest in the business motivates me."

## Starting the conversation on food security

The natural tension between urbanisation and productive land means there are big challenges ahead for the horticulture industry. The Pukekohe hub has something most other regions don't: exceedingly fertile and efficient productive soils, temperate climate, easy and direct access to transport routes and immediacy to our largest city. This means the hub's horticulture production could be a corner stone in our domestic food security, providing for a hungrier Auckland in the future and adding significant value to the regional economy – and New Zealand as a whole. But only if the current challenges to production, including access to appropriate land, are managed in the most effective and efficient way.

The key is how does New Zealand protect and enhance what the Pukekohe hub adds to the Four Capitals of wellbeing? If the demand is growing then the response from the value chain has to be productivity increases within our environmental constraints.

The food security conversation for the Pukekohe hub could focus on:

- |                                                                                                                                                                                          |                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>01</b> <b>Consideration of productive land</b><br/>Adequate and careful planning on land use, including balancing the needs of housing and horticulture</p>                        | <p><b>04</b> <b>Attracting skilled labour</b><br/>Communicating and creating visible opportunities to attract talent and skilled labour into the industry</p>                 |
| <p><b>02</b> <b>Sustainable productivity increases</b><br/>Using innovative technologies to manage the intensification of cropping within environmental limits</p>                       | <p><b>05</b> <b>Sustainable margins</b><br/>Creating a more commercial, demand driven supply chain with less wastage to improve value and ensure a fair return on capital</p> |
| <p><b>03</b> <b>Uptake of new cultivars</b><br/>Investment in the development of new varieties to manage changing conditions, diseases, consumer preferences and productive capacity</p> | <p><b>06</b> <b>Secured access to resources</b><br/>Balancing of domestic and horticulture demands on water through efficient and considered water allocation systems</p>     |



## Next steps and further questions

As the future constraints on production hit home, businesses and government will need to take bold steps. Given the challenges the hub's horticulture production faces, is New Zealand asking the right questions within businesses and between growers, local and central government and industry organisations? To contribute to the debate, Deloitte offers the following questions for consideration by decision and policy makers:

- What needs to be considered to protect and capitalise on the natural growing ability, strategic location, land availability and future growth opportunities of the Pukekohe hub?
- How financially sustainable is the industry and what can industry participants do to foster innovation and encourage demand driven supply to improve value?
- How can government and industry work together to actively develop a food security strategy that considers the needs of a growing population and availability of natural resources?
- What can the industry, government and education providers do to ensure New Zealand is growing tomorrow's growers?
- How can New Zealand ensure that we have efficient water allocation and consents to grow horticulture for the future generation?

Deloitte is agnostic on the way to transition to these changes, but all paths have some challenges. Time and further analysis will help the industry develop the best approach. The challenge the industry is seeking to address – meeting growing demand, and the increasing cost and other pressures of meeting this demand – remains compelling. A new way of thinking is required, and New Zealanders cannot rely on the way they have always done things to find the answers the country needs now.

# Appendix A: Input-Output analysis

Economic contribution studies are intended to quantify measures such as value added, exports, imports and employment associated with a given industry or firm, in a historical reference year. The economic contribution is a measure of the value of production by a firm or industry.

All direct, indirect and total contributions are reported as gross operating surplus (GOS), labour income, value add and employment, with these terms defined in Table A.1.

Table A.1: Definitions of economic contribution estimates

Estimate	Definition
Gross operating surplus (GOS)	GOS represents the value of income generated by the entity's direct capital inputs, generally measured as the earnings before interest, tax, depreciation, and amortisation (EBITDA).
Labour income	Labour income is a subcomponent of value add. It represents the value of production generated by the entity's direct labour inputs, as measured by the income to labour.
Value add	Value add measures the value of production (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value add across all entities in the economy equals gross domestic product. Given the relationship to GRP, the value add measure can be thought of as the increased contribution to welfare.
Employment (FTE)	Employment is a fundamentally different measure of activity to those above. It measures the number of workers (measured in full-time equivalent terms) that are employed by the entity, rather than the value of the workers' product.
Direct economic contribution	The direct economic contribution is a representation of the flow from labour and capital committed in the economic activity.
Indirect economic contribution	The indirect contribution is a measure of the demand for goods and services produced in other industries as a result of demand generated by economic activity.
Total economic contribution	The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

Source: Deloitte Access Economics

## Value added

The measures of economic activity provided by a contribution study are consistent with those provided by the Australian Bureau of Statistics and Statistics New Zealand. For example, value added is the contribution the industry makes to total factor income and gross domestic product (GDP) and gross regional product (GRP).

There are a number of ways to measure GDP:

- Expenditure approach – measures the expenditure of households, on investment, government and net exports
- Income approach – measures the income in an economy by measuring the payments of wages and profits to workers and owners.

Below is a discussion measuring the value added by an industry or firm using the income approach.

#### Measuring the economic contribution – income approach

There are several commonly used measures of economic activity, each of which describes a different aspect of an industry's economic contribution. One measure is value added.

Value added measures the value of production (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value added across all entities in the economy equals gross domestic product. Given the relationship to GDP, the value added measure can be thought of as the increased contribution to welfare.

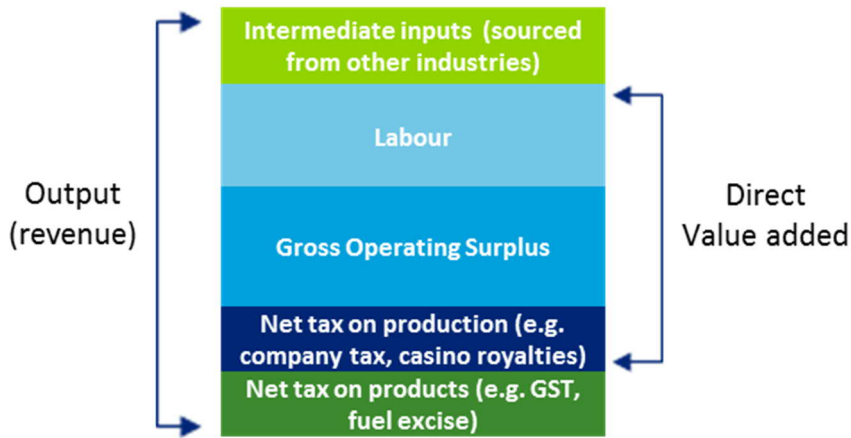
Value added is the sum of:

- Gross operating surplus (GOS) represents the value of income generated by the entity's capital inputs, generally measured as the earnings before interest, tax, depreciation and amortisation (EBITDA)
- Tax on production less subsidy provided for production. Note: given the manner in which returns to capital before tax are calculated, company tax is not included or this would double-count that tax. In addition it excludes goods and services tax, which is a tax on consumption (i.e. levied on households)
- Labour income is a subcomponent of value added. It represents the value of production generated by the entity's direct labour inputs, as measured by the income to labour.

Figure A.1 shows the accounting framework used to evaluate economic activity, along with the components that make up output. Output is the sum of value added and the value of intermediate inputs used by the firm. Net taxes on products are not included in value added but are included in GDP.

The value of intermediate inputs can also be calculated directly by summing up expenses related to non-primary factor inputs.

Figure A.1: Economic activity accounting framework



Source: Deloitte Access Economics.

Contribution studies generally outline employment generated by an entity or industry. Employment is a fundamentally different measure of activity to those above. It measures the number of workers that are employed by the entity or industry, rather than the value of the workers' production.

#### Direct and indirect contributions

The direct economic contribution is a representation of the flow from labour and capital in the company.

The indirect contribution is a measure of the demand for goods and services produced in other industries as a result of demand generated by horticulture growing and processing. Estimation of the indirect economic contribution is undertaken in an input-output (IO) framework using Statistics New Zealand IO tables which report the inputs and outputs of specific industries of the economy.

The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

Other measures, such as total revenue or total exports are useful measures of economic activity, but these measures alone cannot account for the contribution made to GDP. Such measures overstate the contribution to value added because they include activity by external firms supplying inputs. In addition, they do not discount the inputs supplied from outside Pukekohe.

#### Limitations of economic contribution studies

While describing the geographic origin of production inputs may be a guide to a firm's linkages with the local economy, it should be recognised that these are the type of normal industry linkages that characterise all economic activities.

Unless there is unused capacity in the economy (such as unemployed labour) there may not be a strong relationship between a firm's economic contribution as measured by value added (or other static aggregates) and the welfare or living standard of the community. The use of labour and capital by demand created from the industry comes at an opportunity cost as it may reduce the amount of resources available to spend on other economic activities.

In a fundamental sense, economic contribution studies are simply historical accounting exercises. No 'what-if', or counterfactual inferences – such as 'what would happen to living standards if the firm disappeared?' – should be drawn from them.

The analysis – as discussed in the report – relies on a national IO table modelling framework and there are some limitations to this modelling framework. The analysis assumes that goods and services provided to the industry are produced by factors of production that are located completely within the region defined and that income flows do not leak to other regions.

The IO framework and the derivation of the multipliers also assume that the relevant economic activity takes place within an unconstrained environment. That is, an increase in economic activity in one area of the economy does not increase prices and subsequently crowd out economic activity in another area of the economy. As a result, the modelled total and indirect contribution can be regarded as an upper-bound estimate of the contribution made by the supply of intermediate inputs.

Similarly the IO framework does not account for further flow-on benefits as captured in a more dynamic modelling environment like a Computable General Equilibrium (CGE) model.

#### Input-output analysis

Input-output tables are required to account for the intermediate flows between industries. These tables measure the direct economic activity of every industry in the economy at the national level. Importantly, these tables allow intermediate inputs to be further broken down by source. These detailed intermediate flows can be used to derive the total change in economic activity associated with a given direct change in activity for a given industry.

A widely used measure of the spill-over of activity from one industry to another is captured by the ratio of the total to direct change in economic activity. The resulting estimate is typically referred to as 'the multiplier'. A multiplier greater than one implies some indirect activity, with higher multipliers indicating relatively larger indirect and total activity flowing from a given level of direct activity.

The IO matrix used for New Zealand is derived from the Statistics New Zealand 2013 IO tables. The industry classification used for IO tables is based on the Australian and New Zealand Standard Industrial Classification (ANZSIC), with 106 sectors in the modelling framework.

# Appendix B: CGE modelling

The Deloitte Access Economics – Regional General Equilibrium Model (DAE-RGEM) is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy with bottom-up modelling of New Zealand regions. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as GDP, employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based upon a set of key underlying relationships between the various components of the model, each which represent a different group of agents in the economy. These relationships are solved simultaneously, and so there is no logical start or end point for describing how the model actually works. However, they can be viewed as a system of interconnected markets with appropriate specifications of demand, supply and the market clearing conditions that determine the equilibrium prices and quantity produced, consumed and traded.

DAE-RGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

- The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).
- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas (C-D) utility function.
- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the New Zealand regions, households can also source goods from interregional. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interregional), is determined by maximising utility via a C-D utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.

- Producers are cost minimisers, and in doing so, choose between domestic, imported and interregional intermediate inputs via a CRESH production function.
- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply.
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return. Once the aggregate investment has been determined for New Zealand, aggregate investment in each New Zealand sub-region is determined by a New Zealand investor based on: New Zealand investment and rates of return in a given sub-region compared with the national rate of return.
- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interregional sources for these goods via a CRESH production function.
- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other New Zealand regions (interregional exports).
- For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But, in relative terms, imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interregional within the New Zealand regions are assumed to be closer substitutes again.
- The model accounts for greenhouse gas emissions from fossil fuel combustion. Taxes can be applied to emissions, which are converted to good-specific sales taxes that impact on demand. Emission quotas can be set by region and these can be traded, at a value equal to the carbon tax avoided, where a region's emissions fall below or exceed their quota.

Below is a description of each component of the model and key linkages between components.

#### Households

Each region in the model has a so-called representative household that receives and spends all income. The representative household allocates income across three different expenditure areas: private household consumption; government consumption; and savings.

The representative household interacts with producers in two ways. First, in allocating expenditure across household and government consumption, this sustains demand for production. Second, the representative household owns and receives all income from factor payments (labour, capital, land and natural resources) as well as net taxes. Factors of production are used by producers as inputs into production along with intermediate inputs. The level of production, as well as supply of factors, determines the amount of income generated in each region.

The representative household's relationship with investors is through the supply of investable funds – savings. The relationship between the representative household and the international sector is twofold. First, importers compete with domestic producers in consumption markets. Second, other regions in the model can lend (borrow) money from each other.

- The representative household allocates income across three different expenditure areas – private household consumption; government consumption; and savings – to maximise a Cobb-Douglas utility function.
- Private household consumption on composite goods is determined by minimising a CDE (Constant Differences of Elasticities) expenditure function. Private household consumption on composite goods from different sources is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption on composite goods, and composite goods from different sources, is determined by maximising a Cobb-Douglas utility function.
- All savings generated in each region is used to purchase bonds whose price movements reflect movements in the price of generating capital.

### Producers

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors. Intermediate usage is where one producer supplies inputs to another's production. For example, coal producers supply inputs to the electricity sector.

Capital is an input into production. Investors react to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. In addition, the production of machinery, construction of buildings and the like that forms the basis of a region's capital stock, is undertaken by producers. In other words, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

Producers interact with international markets in two main ways. First, they compete with producers in overseas regions for export markets, as well as in their own region. Second, they use inputs from overseas in their production.



- Sectoral output equals the amount demanded by consumers (households and government) and intermediate users (firms and investors) as well as exports.
- Intermediate inputs are assumed to be combined in fixed proportions at the composite level. As mentioned above, the exception to this is the electricity sector that is able to substitute different technologies (brown coal, black coal, oil, gas, hydropower and other renewables) using the 'technology bundle' approach developed by ABARE (1996).
- To minimise costs, producers substitute between domestic and imported intermediate inputs is governed by the Armington assumption as well as between primary factors of production (through a CES aggregator). Substitution between skilled and unskilled labour is also allowed (again via a CES function).
- The supply of labour is positively influenced by movements in the wage rate governed by an elasticity of supply is (assumed to be 0.2). This implies that changes influencing the demand for labour, positively or negatively, will impact both the level of employment and the wage rate. This is a typical labour market specification for a dynamic model such as DAE-RGEM. There are other labour market 'settings' that can be used. First, the labour market could take on long-run characteristics with aggregate employment being fixed and any changes to labour demand changes being absorbed through movements in the wage rate. Second, the labour market could take on short-run characteristics with fixed wages and flexible employment levels.

### Investors

Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. The global investor ranks countries as investment destination based on two factors: current economic growth and rates of return in a given region compared with global rates of return.

- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interregional sources for these goods via a CRESH production function.

### International

Each of the components outlined above operate, simultaneously, in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. Of course, this implies some global conditions that must be met, such as global exports and global imports, are the same and that global debt repayment equals global debt receipts each year.



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