FUTURE OF THE FAMILY FARM

Quantification of the New Zealand Agricultural Industry’s resilience to disruption and strategies to increase this resilience.

Daniel Risi

1 September 2017
ACKNOWLEDGEMENTS

First and foremost, I would like to thank ANZ for sponsoring this innovative scholarship established by Young Farmers. Without their financial support, this project would not have happened.

I would like to thank New Zealand Young Farmers for developing this scholarship and providing a platform that has helped me meet some great young rural professionals. Their forward thinking in offering a scholarship like this, where applicants design the research projects, shows how far the organisation has come in expanding their personal development opportunities to well outside the farm gate. I would recommend this organisation to any young professional operating in the rural landscape. You won’t regret it.

I would especially like to thank Carolyn Bennett, who was fantastic with organising my scholarship and working on marketing strategies for it post completion, especially as due to the nature of the scholarship, it was often difficult at times to administer.

Thanks to Nadine Porter who edited the final report and provided great feedback on some of the concepts I had developed. She also proved that we need many perspectives on the same concepts to minimise bias when developing solutions. Many points in this report were developed after she asked, “have you thought about this implication?”. I look forward to reading her Nuffield report.

Thanks to Exo Protein, for their interview on cricket protein bars. And a special thanks to Aran and the rest of the people at Entomo farms for being so welcoming and open on their cricket farm tour. This was a true highlight of the trip.

Thanks to Ben Anderson and Rosendale farms who took me on great farm tours of their respective dairy operations. The best way to break barriers is by talking and demonstrating how things are actually done. After these farm tours many of my negative opinions about housed dairy cows have been thoroughly proven wrong.

To the many people who I met at conferences and was hosted by over my USA trip, thank you for being so welcoming and genuine. It made this trip a real highlight of my life thus far.

Finally, to the person currently reading this report. Thanks for taking some time out of your day to read this. Hopefully you will be challenged, which should make you question your own farming operation or gain confidence that your current opinions are on the right track.

Daniel Risi
EXECUTIVE SUMMARY

Overall, the primary sector directly contributes just over half of New Zealand’s total export earnings, 67 percent of which is from the Dairy, Sheep and Meat sectors (NZ Treasury, 2017). This valuable component of the New Zealand economy has recently come under threat from start-up companies seeking to disrupt the sector through innovations in Food Technology (FoodTech) such as lab grown meats and pea based milk. This report assessed this disruption risk and outlined strategies for individual farm owners and their co-operatives to minimise this risk to their wealth.

FoodTech innovations look unlikely to cause significant changes to existing Dairy, Sheep and Beef industries in the short to medium term (15 years). This is due to their higher price point compared to agriculture products of comparable quality, and current inability to offer products across the entire meat and dairy product range. This price difference looks unlikely to change in the medium-term due to the extended length of time and capital required by FoodTech companies to establish reliable supply chains and economies of scale. Growing demand of dairy and meat products in developing regions, where 95 percent of the population growth is set to occur until 2025 (OECD/FAO, 2016) will likely offset any gains made by disruptive technologies in this time frame.

The long-term risk of disruption to the existing primary sector is difficult to quantify, but would create a significant impact if it were to occur. In this worst-case scenario, the land required to produce the majority of dairy and meat products would be significantly reduced. The value of which would then become its next best use, either cropping, forestry, finishing or residential/lifestyle housing. This scenario could have serious impact to farm balance sheets, with the wealth of New Zealand farmers and bank loans based of this new land use.

For this scenario to occur, the cost of production of New Zealand primary products and FoodTech companies would need to converge. This could occur as compliance costs for Ag products increase while FoodTech companies establish the scale, supply chains and further product innovations currently restricting their dispersion into current markets.

Consumers will remain the final judge in determining the success of FoodTech and Agriculture companies. If consumers are happy to purchase alternative proteins due to similar taste, texture, price, convenience and environmental footprint as existing offerings and are comfortable with how these products are made, FoodTech companies will achieve significant disruption. Current market trends indicate the FoodTech offerings price point and the significant genetic and plant modification required to produce their product will be the largest barriers that FoodTech companies will need to overcome to achieve dispersion into the meat and dairy markets.
At a farmer level, determining a farmer's risk appetite and ensuring that it matches the current farming business risk level should be a priority. Some methods to mitigate a farmer's wealth from disruptive technologies include:

1. Increase equity position to mitigate minor disruption trends by bringing in an equity partner, sharemilker or purchasing a smaller farm.
2. Use a portion of free cashflow to either:
   a. Create an investment fund which is not used as farm business collateral.
   b. Purchase some sort of income protection insurance.
   c. Increase equity position of farm.
3. Sell farming operation and diversify risk by investing in a variety of investments.
4. Purchase AgTech tools that increase free cashflow of business which can then be used to achieve options 1 and 2.

At a co-opp level, FMCG brands will need to target high value demographics that FoodTech disruptors are unable to cater for by using unique points of difference in the New Zealand Agriculture space. Examples include:

- GMO and GE free.
- High quality control of product.
- Pasture based.
- Minimal processing and editing of food.
- Transparent supply chains.

Brands need to prove the truly unique story that they wish to tell consumers. This can be achieved by leveraging technologies such as blockchain to make supply chains and farm inputs more transparent to the consumer. Reliance on existing high trust FMCG brands is not enough as consumers become less loyal to established food brands and marketing alone.

Co-ops will also need to reduce the point of difference FoodTech companies offer over existing competitors. Currently these include environmental and perceived animal ethics benefits (health benefits such as lactose free target other markets). Any increases in environmental and ethical responsibility by New Zealand farmers will need to translate into more revenue to offset the cost of these measures.

Currently, New Zealand's farming systems are some of the most cost competitive in the world against both traditional and new competitors. The likelihood of this continuing in the long term remains increasingly uncertain and should be factored into business decisions across New Zealand's entire Dairy and Meat value chains.
CONTENTS

Acknowledgements .................................................................................................................................... 2
Executive Summary ....................................................................................................................................... 3
Contents ....................................................................................................................................................... 5
1 Introduction ............................................................................................................................................... 7
2 How to Assess Disruption .......................................................................................................................... 8
  2.1 Overview .............................................................................................................................................. 8
3 Expenses .................................................................................................................................................... 9
  3.1 Overview .............................................................................................................................................. 9
  3.2 Risks to future expense increases ......................................................................................................... 10
  3.3 The role of AgTech in reducing farm expenses ..................................................................................... 11
    3.3.1 Overview .......................................................................................................................................... 11
    3.3.2 Optimisation of Farm Outputs using farm software and the Internet of Things ............................ 11
    3.3.3 On farm field trial technology using Variable Application Rate (VAR) technology .................. 13
    3.3.4 Use of Ag Tech for Nitrogen Efficiently ...................................................................................... 14
    3.3.5 The Issue of Data Sharing – New Zealand’s real opportunity ..................................................... 15
    3.3.6 Final Thoughts on AgTech ............................................................................................................ 15
  3.4 Conclusions on expenses ..................................................................................................................... 16
4 Revenue ................................................................................................................................................... 17
  4.1 Overview .............................................................................................................................................. 17
  4.2 Increasing Revenue: New Zealand’s Advantage in a rapidly changing world ................................. 18
    4.2.1 FMCG brands in the current disruptive environment ..................................................................... 18
    4.2.2 Demographics ............................................................................................................................... 18
    4.2.3 Blockchain ..................................................................................................................................... 19
    4.2.4 Conclusions on increasing revenue ............................................................................................. 20
  4.3 Falling Revenue: An age where Land is Redundant ........................................................................... 21
    4.3.1 Introduction .................................................................................................................................... 21
    4.3.2 The Current FoodTech Landscape ............................................................................................... 22
4.3.3 Cricket Protein ..................................................................................................................23
4.3.4 Soy Protein.....................................................................................................................28
4.3.5 Pea Based Protein .........................................................................................................29
4.3.6 Almond Based Protein with Kite Hill as a case study..................................................32
4.3.7 Yeast Based Proteins ...................................................................................................32
4.3.8 Plant / Lab Based Protein with Memphis Meats as a case study.................................35
4.3.9 Analysis of the disruptors ............................................................................................36
4.3.10 Conclusions on falling revenue due to disruption.....................................................36

5 Recommendations: Methods to build resiliency to a traditional farming business ..........37

5.1 At the farm level...............................................................................................................37

5.1.1 Overview........................................................................................................................37

5.1.2 Recommendations at a Farmer Level ...........................................................................37

5.2 At the processing level.....................................................................................................40

5.3 Final Thoughts...............................................................................................................41
1 INTRODUCTION

Ask anyone who was raised on a farm what their thoughts on their upbringing are, whether they be from a sheep and beef station, or a small dairy unit on the slopes of Mt Taranaki, they will most likely say the same thing; that they couldn't have asked for better.

There are many reasons people go into farming. It is hard work; a lifestyle choice rather than a 9 – 5 career; but if you put in the work, you can get ahead and build a good life for yourself and family. It provides an opportunity to be your own boss, and have a level of autonomy not seen in many other careers. It also allows their offspring to enjoy the same pleasures of living on a farm that they themselves often had the privilege of experiencing.

I believed agriculture was here to stay. The way we farm may change slightly, just like it was different three generations ago, but the fundamentals would remain the same; growing meat, wool and milk using animals on pasture. However, this worldview changed after reading a book called “The Rational Optimist” by Matt Ridley. He outlined that although capitalism is a great system that has raised our standard of living tremendously, it also leaves a wake of creative destruction. Past industries and companies have been wiped out as a by-product of our rise in wellbeing. This concept, in conjunction with his demonstration that food production was the last thing left to be produced from land resources made me consider what I thought impossible:

Can the New Zealand agriculture be disrupted to a point where the way we think of farming is completely different than what it currently is? What would that impact result in?

The internet has turned traditional monopolies like print newspapers on their heads. The digital camera turned Kodak from one of America’s finest blue-chip companies to a shell of its former self. (its stock price went from $94 to $2 over a 10-year period (The Wall Street Journal, 2017).

Could the same happen to a company like Fonterra?

I was awarded this scholarship from Young Farmers and ANZ to help answer this question. I travelled to America to look at who and what could disrupt the New Zealand Agricultural sector, how it could occur, and if there are ways to minimise this risk. This report is aimed at farmers who are interested in the concept of disruption in general and would like to know more information about this concept. It also looks at possible options to make their business more resilient to disruption.
2 HOW TO ASSESS DISRUPTION

2.1 Overview
Disruption of an industry involves fundamental change to the way an existing business operates. Assessment of New Zealand’s resiliency to, and quantifying the scale of this disruption is essential for long term risk management of the New Zealand Agricultural Industry. Figure 1 outlines how varying revenue and costs can alter a farm’s resiliency to disruption. Assessment of how these variations could occur will be the focus of this report.

Figure 1: Overview of how a change in input could impact a typical New Zealand farm’s revenue or expenses and its ability to withstand disruption.

Background information that provides further context of New Zealand’s agricultural system compared to the rest of the world is provided in Error! Reference source not found.
3 EXPENSES

3.1 Overview

As outlined in Figure 2, a New Zealand farmer can build resiliency into their farming business by either increasing the revenue or reducing expenses of their operation. Expense reduction per unit of output is largely where the traditional farmer has focused. This is because revenue for the farming business is largely dictated by the decisions made by outside the farm gate by the suppliers. Organisations such as DairyNZ and Beef and Lamb have a wealth of information on how a business owner can achieve a reduction in farm costs and so will not be covered in the report further.

There is a limit on a farmers’ ability to reduce the cost of their business using current technologies and knowledge. Any further cost reduction from this lower limit will need to be achieved by advancements in either new agricultural technology or farming knowledges. The magnitude of impact will be determined by what area of expenses this innovation impacts. Figure 2 outlines the areas that account for most of farms working expenses.

If a new agricultural technology causes expenses to decrease across the entire global food segment of an industry, any productivity gains will be offset with a decrease in revenue due to global competition maintaining current margins (see Figure 1). This is still beneficial to New Zealand agriculture, as it increases the sectors resiliency against companies attempting to disrupt the sector.

If a global innovation breakthrough or new regulations cause expenses to increase, there could be a slight negative impact to the industry, as it reduces the barrier to entry of a disruptor entering the market.

Therefore, the preferred AgTech innovations for New Zealand farmers is technology that provides New Zealand agriculture a significant advantage over existing global competitors. This will increase both profitability and resiliency to disruption.
3.2 Risks to future expense increases.

Recently, land in New Zealand that has been allocated for food production has had greater constraints put in place to account for the negative externalities associated with agricultural production. These constraints are largely in the form of complying with new Regional Council Environmental plans and in the future, the Paris climate agreement. Specific Regional Council constraints can be found in their respective regional plans. The impacts of agriculture to the global environment are outlined in Error! Reference source not found.. Compliance costs associated with these constraints will likely be where significant expenses will occur in the future to maintain current farm output. These constraints will also result in an effective upper limit in food production being placed on catchments, as the cost per extra unit of output becomes prohibitively high due these additional compliance costs.

If all competitors are exposed to the same level of environmental constraints, the cost and price of a product will rise to factor in these costs. Unfortunately, most of the primary sectors competitors are based in overseas markets, where domestic constraints on food production to mitigate against environment constrains are often either minimal, or offset by generous subsidies by their respective regulators (see section Error! Reference source not found. in Error! Reference source not found. for further information). The result is that the increased cost of compliance to New Zealand’s farmers will not increase the price of products they sell on a global market. This could erode the profitability of all New Zealand’s farmers, not just farms unable to meet environmental constraints.

Accurate environmental constraints, when used well, are critical to the future of farming in the medium to long term. They should help reflect the true profitability of a farming practice by pricing the cost of negative externalities properly. This will allow sustainable farms to thrive, with farms that are currently surviving at the expense of the environment to be sold to better operators or change to a more sustainable land use.
3.3 The role of AgTech in reducing farm expenses.

3.3.1 Overview
There are two key ways to overcome expense increases:

1. Move to high value markets that pay a premium for environmentally and ethically produced products. (See Section 5.2)
2. Invest in AgTech that offset increase in expenses by reducing farm expenses elsewhere in the business or increasing output from the same inputs used on farm.

After attending the InfoAg precision agriculture conference in St Louis, there appears to be significant progress being made in the AgTech space in North America. Applying some of these innovations to New Zealand farming systems where applicable is important to prevent overseas competitors receiving all the benefits. Key innovations demonstrated at the conference that may be relevant to New Zealand farming systems are outlined below.

3.3.2 Optimisation of Farm Outputs using farm software and the Internet of Things
Variable Application Rate (VAR) technologies allow machines to vary the rate of a given input onto a paddock as the machine moves. Some examples of this would be increasing the seeding rate in a paddocks fertile soils, or decreasing nitrogen application to a section of the paddock that already has enough. This occurs in real time, as the seeder or fertiliser spreader tracks over the paddocks.

VAR technologies have been around for at least five years (Info Ag Conference, 2017), however the decreasing cost of these tools is allowing for increased dispersion in the arable market. The addition of new software to help identify and optimise these tools has also improved.

An example of one of these technologies is Climate Corp. The company's product 'FieldView' gathers data on the soil properties of the farm, as well as application data on seeds rate application, fertiliser applications, and harvest yield information. After the first harvest using this programme, this software will be able to provide information and analysis in a user-friendly way on which plants preformed best in which soil types, as well as checking other factors affecting growth rates such as which areas had appropriate nitrogen (see Figure 3). The result is an improvement to optimising crop yields for smaller areas of land so that profits for each m² of soil are also optimised by increasing revenue without requiring any extra inputs costs.
Programmes such as these are impressive in their ability to gather and analyse data. A key point to note is that weather patterns pay a significant part in optimising crop selections, growing strategies and ultimately, farm profitability. After attending multiple weather forecasting seminars and weather forecasting programme demonstration booths at the Info Ag Conference, it became apparent that providing an accurate weather forecast for timeframes greater than two weeks is incredibly difficult. This issue remains a key obstacle with the optimisation of precision agriculture in growing plant products.

Image 1 highlights the amount of companies demonstrating products at the Info Ag Conference. A large percentage of these are software companies, doing similar things as Climate Corp. I would assume that there will be some consolidation of these programmes as they seek to become sustainable, profitable businesses. (Climate Corp, one of the largest in this space is still yet to turn a profit. (Climate Corp, 2017).
3.3.3 On farm field trial technology using Variable Application Rate (VAR) technology.

Premier Crop Systems (PCS) has released new technology that allows for multiple enhanced learning blocks in a single crop field. The idea is that spatial variability makes determining the limiting factor for plant growth difficult within local fields when using the 15 university trials per state as the sole information source for planting decisions. Using VAR technology, PCS plants learning blocks in the crops field to alter things such as seed population and fertiliser inputs when the crops are sown to make trial blocks in the field. The results of these outputs are then recorded and analysed using the harvest yield data for the field.

This system of gathering data means that the amount of data available to farms to make crop planning decisions could be based from 10 to 60 thousand learning block results, as opposed to the 15 that are currently used (Info Ag Conference, 2017).

![Enhanced Learning Blocks](image.png)

The quantity and quality of this data could improve yield results for many farmers as there is now more data available from more relevant locations about the limiting factors of plant growth than in previous years. It also allows new crop products to be validated and trialled in the grower's field before widespread implementation rather than relying on non-farm results.

This data is also important to the predictive models used to forecast crop yields that multiple software application use. These models are response trial hungry, and using this software would greatly increase the accuracy of these big data and machine learning models.

Crop growing tools are increasingly becoming variable rate to enable and grow this level of data and analytics and further increase the accuracy in determining the limiting factor of crop yields in various locations and climate scenarios in the future.
3.3.4 Use of Ag Tech for Nitrogen Efficiently.

Using a fields image to determine nitrogen deficient areas has seen increased dispersion into American farms over the last two to three years. By creating a map of the crop growth, imaging software can detect where there is discoloration occurring in the crop (i.e. areas where the crop appears to be yellow). This map can be used as an indicator of nitrogen deficiency which allows for greater accuracy in the application of nitrogen to farms.

The issues with the current technology is that an accurate map requires a drone to map the field. Previously, this was very labour intensive, and required specialist drone handling knowledge. The other option was to use satellite imagery which was less labour intensive but gave a less accurate picture of the fields condition (Info Ag Conference, 2017).

Drone technology has now reached a point where they can be programmed to fly autonomous routes automatically. There are many software companies providing this mapping service which can then be fed into software analytics companies such as FieldView for further analysis or be sent directly to the drone operators iPad so they can inspect the field as soon as the drone has finished.

Image 2: Drone leaves to undertake autonomous mapping of nearby corn crop at the 2017 Info Ag Conference demonstration day (Info Ag Conference, 2017).

After attending this conference, it became apparent that there was less emphasis on optimising nitrogen use due to increasing environmental regulations as in New Zealand, with the focus on yield increases instead. The programmes that New Zealand uses to monitor nitrogen leaching such as Overseer appear to not be in use in the Mid-West cropping sector. As Overseer continues to improve, I believe that New Zealand has a head start in using technologies such as this to help create greater transparency in the environmental footprint of our products. This is something that consumers are increasingly demanding from their products (Future of Food Tech, 2017).
3.3.5 The Issue of Data Sharing – New Zealand’s real opportunity.

Multiple discussions with various stakeholders at the InfoAg Conference, both informally and in presentations were focused on addressing the issue of data sharing in the AgTech sector.

It appears farmers are unwilling to give up the large amounts of AgTech data they generate on their farm. If all this data was pooled, the development of optimal farming practices would rapidly increase. The machine learning algorithms used by software companies require vast quantities of data to have real value, and will never be as effective if not given access to the farmers data.

The reason why farmers appear to be apprehensive about sharing this data comes from structural issues within the farming space of the USA. Competition for local farming blocks at a local level is often intense, and with varying ownership models, (i.e. lease, profit sharing or purchase) any information about yield performance that someone has about the farm in question is held onto tightly and gives them significant competitive advantage when trying to secure that block.

The issue is exacerbated by the fact that the data that is shared, is collected across a variety of independent software companies, each one unwilling to share this information with other competitors. This is largely to an attempt to compile the largest database available, increasing their competitive advantage.

This presents a great opportunity to New Zealand farms. Our co-operative business models at a supplier level and simpler farm and business ownership models at a local level, results in less resistance to giving up farm data gained from AgTech to be used by third parties. I believe that there is an opportunity for an industry organisation such as Dairy NZ to oversee this data, which will give AgTech companies the ability to access one large data set and compete on the value of their product, rather than the size of their own data sets. This model would also allow farmers to still maintain control to their data sets by interacting only with the trusted industry organisation. If this data sharing model is adopted in New Zealand, there is a real opportunity to create AgTech products that create significant value to New Zealand farmer that would be difficult to achieve in overseas environments.

3.3.6 Final Thoughts on AgTech

Innovations in AgTech could provide significant improvements to the global agriculture space. If these benefits equally improve all farming models, the profitability of New Zealand Agriculture will most likely be unaffected, however its resilience to disruption from FoodTech innovations would likely increase.
The ideal AgTech innovations are relevant to New Zealand farming systems only as these would increase New Zealand agriculture’s profitability as well as build further resiliency to the New Zealand farming system. These innovations should be the focus of AgTech investment by the New Zealand primary sector.

Because New Zealand's farming system is structurally different from the bulk of farming practices overseas, by focusing on New Zealand specific AgTech innovations the risk of a Global AgTech innovations missing New Zealand's farming systems is somewhat mitigated.

3.4 Conclusions on expenses.

After completing this study, it is the authors opinion that any expense reduction either through increased knowledge or AgTech innovations in the future will have minimal impact on profitability on farm. This is due to the following points:

- The New Zealand farming system is already one of the lowest cost producers of milk and meat goods in the world (IFCN, 2015) and have less room to decrease than overseas competitors.
- AgTech Innovations currently appear to be better suited to specialised, large scale overseas operators who either produce the feed or feed the animals, not both.
- Any reduction in expenses will be likely offset by increases in compliance costs associated with mitigating global and local environmental damage associated with farming in New Zealand.

Any long-term growth in profitability will likely come from increased prices received from products produced on farm by either increased demand of commodities or increasing the value of the product sold.
4 REVENUE

4.1 Overview
Revenue growth in an increasingly disruptive environment will be critical to the long-term survival of the New Zealand primary sector. Although technologies that could cause a potential decrease in revenue are largely outside of the farmers control, assessment of this risk is still important to determine if one should continue to invest in New Zealand agriculture. Strategies to achieve increased revenue and profits are wide spread and well researched. Such strategies can be found in many reports such as KMPG’s agribusiness agenda, and are developed by people with greater resources, expertise and experience in this field than myself. As such this section will focus on adding to this discussion by presenting information I obtained over my time at the InfoAg and Future of Food Tech conferences as well as other interviews and research.

Decreased demand for milk and meat products by consumers looks unlikely to eventuate in the long term as population and wealth continue to rise in developing nations (OECD / FAO, 2016). Revenue decreases will largely be due to oversupply (Wyrzykowski, 2016). This risk of oversupply can come from either improvement in existing overseas competitors, or introduction of alternative milk products gaining significant market share in existing agriculture markets and may result in existing suppliers competing in a much smaller market than originally predicted.

Although there are other factors that can lead to revenue decreases such as biological risks, these appear to largely be quantified, assessed previously, and already somewhat built into the price of purchasing agriculture businesses and are therefore not analysed further. Assessment of the risks of revenue decreasing on farm due to disruption will be the focus of this section.
4.2 Increasing Revenue: New Zealand’s Advantage in a rapidly changing world.

4.2.1 FMCG brands in the current disruptive environment.

The final roundtable session from the Future of Food Tech Conference involved venture capitalists and angel investors discussing the current landscape of FoodTech.

Some key points from this discussion were with regards to the disruption of current FMCG brands rather than FoodTech innovations. Alan Bankier from the New York Angles spoke about the recent sale of Sir Kensington (a condiment brand) to Unilever. He speculates Unilever purchased this to maintain and boost value by adding a new brand, as market share of established brands has waned. He pointed to the fact that consumers are willing to experiment and try new food brands, purchased from non-traditional sources for the first time in generations as a reason for established brands waning. This sentiment was confirmed by the round table, with one mentioning in the USA, 85 percent of food was purchase in standard supermarkets compared to only 45 percent today. This process is creating volatile times in the FMCG space as well as the FoodTech area. And means that any brand (both new and existing) needs to be built on stable foundations or risk becoming irrelevant.

Below is a possible strategy to help increase a FMCG brands durability to disruption.

1. Identify a unique factor in the product creation process that would be difficult for an incoming FMCG brand or FoodTech start up to replicate that a consumer is willing to pay a premium for. i.e. low input, grass fed beef or lack of genetically modified organisms
2. Identify the target markets minimum factors required for them to purchase these products i.e. from an environmentally sustainable source.
3. Create systems to prove these unique factors and minimum factors exists in the brand and can be proved by providing transparent and are easily accessible information to the consumer such as a product supply chain information.

4.2.2 Demographics

The world populations need to be fed is a main driver of food prices. This is set to increase from 7.4 billion in 2016 to 8.1 billion in 2025. 95 percent of that growth will occur in developing countries, which will not account for 85 percent of the world's population (OECD / FAO, 2016). The increase of wealth of this population, especially in developing nations outlines a 20 percent growth of dairy products and 7 percent of meat products consumed per person in developing nations by 2025. See Figure 5.
Developed counties appetite for alternative protein indicate resistance to the idea in the short term. 78 percent of people surveyed in the USA would not eat lab grown meat (Pew Research, 2014) with a similar response in the EU (European Commission, 2005). These market sentiments often change due to product dispersion. This indicates demographic barriers for new food tech companies in the short term and will likely not offset the demographic growth in demand for milk.

Increases in meat and dairy demand from developing countries appear to offset the slower growth in demand in developed countries caused by uptake of alternative proteins and falling demand. Sales of dairy milk is expected to fall by 18 percent in the USA from 2015 – 2020 (Mintel, 2016).

If the cost of production of dairy milk and meat in New Zealand remains low relative to competitors (IFCN, 2015), revenue in the short to medium term will likely grow. This is because price is the major determinant in food purchasing decisions in developing countries which is where the bulk of population growth is set to occur (Tatiana Andreyeva, 2010).

4.2.3 Blockchain

Blockchain technology can create secure, transparent and accountable supply chains both on farm, as well as from the farm gate to the consumer. It will be a great aid in building trust in a products true source. Blockchain technology was discussed at length at both conferences. The technology is cheap and robust which enables producers to provide a level of assurance to their consumers that what they are consuming is genuine and traceable.

Blockchain technology can also allow large companies to greatly increase the accuracy and speed of identifying and solving problems in the supply chain such as easily identifying the specific location or process that is causing a product to be unsafe, reducing the size of a product recall.
This technology has the potential to increase revenue to suppliers in multiple ways.

- Cost of recalls and brand damage will reduce as recalled products will be able to be isolated, and the underlying problem easily targeted.
- Consumers will have greater access to trusted and reliable information about products, giving greater credibility to truly high value products.
- Competitors who offer fraudulent claims on their products will be unable to back up their claims, causing brand damage.

This technology will also diminish the reliance of a consumer to trust a product based on the brand alone. New brands with honest, valuable supply chains will require less time to build trust with the consumer and can demonstrate value using a transparent blockchain. This may erode the value of existing brands that are highly trusted by the consumer as they are either unable to offer supply chain proof to back up that trust or that they offer a superior product than cheaper alternatives. The result is that the consumer trust component of a brand may become less valuable.

I believe blockchains ability to create transparency in the food supply chain will be a major benefit to companies that offer genuine quality products, and will significantly impact substandard products that have relied on marketing alone to demonstrate value. This may have a negative impact on New Zealand agribusiness as countries that have a poor reputation for quality control and assurance are able to remove this reputation by establishing trusted supply chains and quickly identifying weaknesses in these supply chains with the use of blockchain technology.

4.2.4 Conclusions on increasing revenue

The population growth of the developing world will increase demand for meat and dairy products in the medium term (OECD / FAO, 2016). These consumers will be price sensitive and rely on the cost of existing meat and dairy products to be less than their FoodTech equivalents for this to be classed as a revenue opportunity. This appears to be the case in the medium term.

The increase of greater transparency in supply chains due to technologies such as blockchain and the growing tendency for less loyalty to established FMCG brands, means that any strategy to increase the value of a product using high value FMCG brand will require demonstrable proof that products are produced to the high standards set by consumers. Relying on an established brand alone is not enough.
4.3 Falling Revenue: An age where Land is Redundant

4.3.1 Introduction

A significant reduction of farm revenue would have major repercussions to existing farmers in both the dairy and dry stock dairy sector. Based on the DairyNZ 2016 economic survey and information on wealth by Statistics NZ, I have assumed that most farmers in NZ have most of their wealth in their farming business. Many of these businesses are highly leveraged (DairyNZ, 2017), further increasing the risk that disruption in earnings to a framing business may have significant long-term impacts to the wealth of New Zealand farm business owners.

FoodTech is a branch of food science that focuses on the production and processes that makes food. Historically, this focus has been on ingredients grown from agriculture to create new food products. This focus has changed recently to creating new sources of the ingredients that do not rely on traditional agriculture methods. In the last two years, the amount and sources of funding and resources available to companies has increased significantly. This section will look at the FoodTech landscape to educate farmers on what is currently out there, and the risks of FoodTech innovations offering significant disruption risks to their farm businesses.

For the assessment, the following five constraints were used to determine a FoodTech’s products ability to become a significant disruptor to the New Zealand primary industry.

- The nutritional benefit must be the same or greater than the agriculture based equivalent.
- Have the ability to be sold at a similar price point to its agriculture based equivalent.
- Have the same properties as its agriculture based equivalent. i.e. taste and texture.
- Consumers must be convinced and trust that product offers the above benefits.
- The product must be sold at convenient, accessible locations.

Image 3: Presentations at the Future of Food Tech New York
4.3.2 **The Current FoodTech Landscape**

Recent developments in 2017 that indicate momentum in FoodTech space include:

- Currently 160 start-up accelerators in FoodTech Space (Future of Food Tech, 2017)
- Tyson, one of the largest meat processors in the world has established a US $150 million fund to invest in emerging FoodTech start-ups. This trend is not unique, with companies such as Fonterra, Kellogg’s and Campbells Soup all starting new VC arms to their business. (Future of Food Tech, 2017)
- Existing FoodTech Venture capitalists are noticing more competition from IT VC’s who may be underestimating the complexities associate with the FoodTech space. This is leading to valuations possibly becoming too high for some FoodTech companies. (Future of Food Tech, 2017)

The Future of FoodTech conference highlighted some key points to consider when assessing emerging FoodTech companies as either a risk or as a possible investment opportunity.

Most FoodTech VC companies only invest in ethical and environmentally conscious companies. They also understand that although consumers say that they purchase products for these same reasons, **what consumers actually purchase is based on price, taste and convenience**. This results in VCs investing in products that consumers want not what they aspire to be and have environmentally and ethically advantages as a side advantage.

**The success of FoodTech start-up will take longer to attain, and will not achieve the same magnitude of success that we have seen in the IT start-up landscape.** This is largely since FoodTech deals with a physical, perishable product that often requires a complex supply chain and strict regulatory approval to get to markets. Most established FoodTech VC’s understand that the time to achieve any real scale in a FoodTech investment is at least 10 years and often will need to be involved for about 7 years on average before exiting (Future of Food Tech, 2017).

A FoodTech start-ups long time to achieve scale, requirement of specialised supply chain knowledge and large inputs of capital to achieve a large, profitable company, has created a **unique opportunity for large existing companies to work with the start-ups that could disrupt them in the future.** They can provide capital, supply chain knowledge, work on a longer time horizon and are not expecting the blockbuster investment that traditional IT VC firms may expect.
FoodTech companies are focusing on building strong brands before the product is released. By developing strong brands and the product in tandem, companies can reach customers as soon as a product is released, rather than building a reputable brand post product launch. In some cases, brands are often being developed at a faster rate than that actual product. This makes analysis of these companies difficult. Examples include Perfect Day Foods, who released an article to New Scientist at a time when their project had only just been accepted into a start-up incubator. The brand grew rapidly before any conclusions about the viability of the product could be determined (New Harvest, 2017).

Companies are outlining the need to re-educate the public on Genetically Modified Organisms (GMO's) in order for large innovations in Food Tech to be successful.

Most of the significant innovations that could occur in the FoodTech space rely heavily in the use of genetic editing (GE) and/or GMO. (GMO's involve the transgenic introduction of foreign adding DNA from foreign sequences found in other plants or animals, while GE is the precise editing of and organisms genome. (Huang, 2016))

GMO's have become unpopular with high value consumers. According to discussion at the Future of Food Tech conference, this was thought to be due to poor education of the public about GMOs and the focus of GMOs on the farmer benefits (i.e. roundup resistant crops) rather than creating GMO products that benefited the consumer. For new FoodTech innovations that rely on GE or GMO to compete at a higher price point than existing products, they will need to rebuild the consumers trust in GE and GMO products and educate so they know the differences between them.

4.3.3 Cricket Protein

Although often not considered a key disruptor (Future of Food Tech, 2017), crickets are a regular part of the diet for 2 billion people on earth (FAO, 2013). These cricket consumers are in developing regions where 95 percent of the population increases over the next 10 years will occur (OECD / FAO, 2016). This creates the possibility that it may take greater market share of this new populations food consumption than previously forecasted. Crickets were already grown to feed pets in western cultures, and so provide good information about FoodTech business that are not constrained with developing supply chains. The following case studies of Entomo Farms and Exo Protein outline the strengths and weaknesses of this alternative protein source in further detail.
Entomo Farms – The largest cricket producer in North America.

Entomo Farms, located two hours north of Toronto, are one of the largest cricket growers and producers of cricket flour as a human food source in North America (Watson E., 2016). Operations like Entomo farms are likely to grow as crickets become an acceptable source of protein in the western world. I was fortunate enough to visit the farms earlier this year.

90 percent of Entomo’s revenues are as a wholesale supplier of whole crickets or cricket flour. This is then turned into cricket protein products by their customers. It is also one of the few vertically integrated businesses in the industry, with 10 percent of their business offering products direct to the consumer (Watson E., 2016).

The clear advantage of using crickets as a protein source is in animal ethics since farmed crickets live almost to the end of their natural life cycle, being harvested just days before they would normally expire. (Hinton, 2017). There is no incentive to shorten this lifecycle as this inhibits reproduction rates. No other meat can offer this point of difference. Crickets also prefer compact living spaces. This creates a naturally space efficient farming environment. Because they are cold blooded and skin breathers, euthanisation methods that involve freezing or the use of carbon dioxide minimize pain and distress by simply placing the cricket into a deep sleep that do they not wake up from (Hinton, 2017). This is arguably one of the most humane ways that killing animals can be achieved.

Although there are questions as to whether the cost of production of cricket protein makes it sustainable long term, Entomo Farms has claimed that they have reduced their wholesale costs over the last two years by over 40 percent as well as increasing the size of their growing facilities from 5,000 to 60,000 square foot (Watson E., 2016). The trend is in the right direction, however at current prices of $20 dollars per pound for cricket flour compared to $6 for ground beef (Wiley, 2014), there is still significant movements in price required to be cost competitive with current protein products.

Has Entomo’s growth been due to out competing their competitors? A natural growth in demand for cricket based proteins from existing alternative protein consumers (i.e. vegans)? or a result of changing markets and more mainstream consumers accepting cricket protein? Only the later will have the most impact on existing meat and dairy producer, and it remains unlikely to be significant long-term due to the differences in taste and texture of cricket protein.
CRICKETS NUTRITIONALLY

Crickets contain 3X more iron than ground beef, as well as your daily dose of vitamin B12.

2x the amount of protein than beef

Complete protein, containing all essential amino acids.

High in vitamins and minerals, packing 5X more magnesium than beef. Magnesium is essential for muscle recovery and calcium absorption. Studies have shown that magnesium can decrease heart disease by 25% and type II diabetes by 1/3. (Which is a major problem among children)

Since you are eating the whole animal you are getting iron, B12, calcium and zinc.

High in fiber.

CRICKETS ENVIRONMENTALLY

Produce virtually no methane, reproduce extremely quickly, and require minimal feed, water, and space.

It is estimated that crickets are 20x more efficient to raise for protein than cattle.

A large number of studies have shown that low DHA and omega-3 fatty acids are associated with problems with intelligence, attention and behavior. Cricket protein is high in DHA and has the perfect 3:1 omega-3 to omega-6 ratio.

Iron is another nutrient that is essential for brain function; crickets contain 3 times more iron than ground beef. Studies show that when children are fed the appropriate levels of iron their ADHD symptoms improved.

ENTOMO FARMS

Goal is to provide healthy grain free, low sugar, high protein products to kids. Ones that aren’t highly processed and filled with additives.

Using the most sustainable source of protein that will help fuel kids active, growing brains

kids are creatures of habit & they love snack items (cookies, granola bars, & cereal). We need to provide healthy products that are made with high quality ingredients that will provide them with good nutrition as well as the conveniance of a snack item.

EFFECTS OF CHILD OBESITY

Nearly 1/3 of children are overweight.

40% of girls and 1/3 of boys in 2000 will have type II diabetes.

It is predicted that the next generation of kids will die before their parents.

25% of our grocery store dollars goes towards processed food.

Kids consume over 100 lbs of sugar each year.

The number of children that are diagnosed with attention deficit disorder, depression, and generalized anxiety disorder are increasing.

We need a new source of protein, one that can sustain the world into the future.

Earth’s population is growing by 75 MILLION people each year.

To meet the demands of this immense growth, we’ll have to triple our food production. Conventional livestock is simply not a sustainable food source on the whole producing more greenhouse gases than the entire transport sector.

<table>
<thead>
<tr>
<th>HEALTH</th>
<th>SUSTAINABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>20%</td>
</tr>
</tbody>
</table>

Entomo products are 20x more efficient than cattle.

Entomo creates life less methane than cattle.

Entomo creates less solid waste than cattle.
Image 4 (left): Typical mature crickets living environment.

Image 5 (below): Once the crickets have reached the final stage of growth the last four weeks are spent in an environment like this.

Figure 6 (Previous Page): Overview of environmental and health benefits of crickets as a food source compared to traditional western food sources.
Exo – Cricket Protein Bars.

Exo protein is a small start-up that makes protein bars using cricket flour from Entomo Farms as the protein source.

What makes this company significant is that it has managed to create and bring a product to market which challenges and more importantly, overcomes the common western worldview that protein must come from animals rather than insects. If this change in sentiment spreads to areas outside of the protein bar industry, significant impact on where consumers source their protein may occur. This company is unlikely to cause significant disruption directly to the existing primary sector due to the small size protein bars play in the global protein market. Further information about Exo’s brand strategies are outlined in Error! Reference source not found..

Figure 7: Overview of the benefits of using Crickets as a protein source compared to other meat alternatives (Exoprotein, 2015)
4.3.4 Soy Protein

In the last 10 years, the use of soy as a protein source has achieved greater dispersion into existing western markets (Future of Food Tech, 2017). This has been largely due to soy becoming popular among lactose intolerant consumers and increased awareness among consumers about the negative environmental impacts of traditional milk sources. Its market share peaked in 2015 and has since lost market share to other plant and nut milk alternatives. These alternatives tend to have superior health benefits and are more likely to be GMO free (Rowland, 2017). Soy milk will only be a key disruptor if it can achieve the same taste as dairy in other uses such as yoghurt and cheese, is priced competitively and demonstrates environmental advantages. Soy milk has been in the market for 40 years, with established supply chains and has not been able to significantly disrupt the existing dairy market today and looks unlikely to be the case in the medium term. The case study of Soylent below outlines innovative ways of using soy protein and also challenges our perception that food must be eaten as a meal, three times a day.

Soylent

Figure 8: Overview of Soylent’s Marketing

Soylent create engineered products that have the optimum amount of daily required protein, carbohydrates, lipids and micro nutrients without any negative food ingredients in one liquid serving. This serving replaces a single meal, is easy to consume, and does not require any time to prepare or clean. The company has received funding from top tier IT VC’s such as Anderseen-Horowitz and have products out in the market place already.

Although Soylent is well received in San Francisco, comments of it “tasting like wet cardboard” (Murphy, 2016) and my own taste experience indicate it may struggle to replace food. Product recalls of Soylent bars in 2016 outline potential quality control issues in their supply chain.

I remain cynical of Soylent’s ability to fundamentally disrupt the food sector. I believe there is a joy in preparing and eating a variety of food which products like Soylent will be unable to replace.
4.3.5 Pea Based Protein

Pea based proteins have produced some of the most potentially disruptive FoodTech companies to the existing sector in the short to medium term (Future of Food Tech, 2017). Peas are used as a primary ingredient due to their relatively high protein levels, market availability, and ease of configuring into different textures (Green, 2017). These features are an essential part of creating burgers that could replace the traditional meat burger.

An important note is the controversy surrounding using genetically modified ingredients in these offerings. Recent articles have shown environmental advocates requesting the removal of the Impossible Burger from market as the EPA is unable to confirm if its GM ingredient, HEME is an allergen. (Note that Impossible Foods can sell the burger regardless of the FDAs approval on this subject.) This underpins a key consideration with alternative proteins which is **are consumers comfortable with using GM to achieve these meat free results?**

Currently the two largest companies making an impact in pea based meat are Impossible Foods and Beyond Meat. These companies are both analysed further below sue to their different marketing strategies. Ripple foods, a pea based milk alternative are also assessed below.

Image 6: The Impossible Burger for sale at the San Francisco baseball stadium.
Beyond Meat. 
Beyond Meat uses plant based materials (predominantly peas) to create burgers and meat strips with a taste like animal burgers. The company is well funded, with Bill Gates, and Obvious Corporation being early investors. Rather than trying to cater for the existing vegan market, Beyond Meats targets existing meat eaters, who decide to purchase Beyond Meat as it tastes the same as meat. 2017 has provided significant penetration into Wholefoods Supermarkets since starting distribution in 2016 and recently has been granted access to sell its burgers in the meat isle of the USA’s largest supermarket, Kroger’s. This has tripled its existing distribution reach in the USA (Beyond Meat, 2017).

At June 2017, the cost of the Beyond Burger is about $12 per pound at Wholefoods. This is just less than double organic grass-fed beef burgers currently for sale at $7 per pound. Whether this is due to Beyond Meat not being able to build facilitates to scale and decrease its price or simply enjoying higher margins on its small product stock remains to be seen. At this stage, its significant price premium will make it unable to take significant market share from traditional agriculture.

Impossible Foods
Impossible foods were founded in 2012 with the aim of making a plant based burger with the same taste, texture and colour as a traditional beef paddy equivalent. The company’s key breakthrough was being able to produce vast quantities of an ingredient called Heme (short for soy leghaemoglobin) which is created using genetically modified vegetables in their lab (Robinson, 2016). Haemoglobin is abundant in traditional meat and gives blood its colour, turns meat pink when cooking, and gives meat its signature aroma. Any plant based product with the aim to create a meat equivalent needs to have levels of haemoglobin like traditional meat. This is inherently difficult to do, as plants have naturally low levels of the substance (Robinson, 2016). By adding Heme to their burgers, Impossible Foods can create a plant based burger that behaves like traditional meat burger patties. I can confirm these offerings taste very similar to their meat based competitors.

Unlike Beyond Meat, Impossible Foods has decided to market and sell its burgers directly to restaurants rather than to consumers. This is an effective strategy, as over half of all burgers sold in the USA are from restaurants (Future of Food Tech, 2017). It also provides greater brand protection in the early stages of distribution due to greater control of the taste experience of the consumer, as Impossible Foods can choose who prepares its product as their supply chain grows.

The company has received over $75 million in VC funding to grow the business, and in 2016 turned down a reported $200 million from Google to purchase the company.
**Ripple – Pea Based Milk**

Pea milk is relatively new to milk alternatives, with less than 5 years in the market. (Watson E., 2016). Companies like Ripple use peas to make a milk based product designed to compete with existing dairy milk consumers. Figure 9 to Figure 12 outline the environmental benefits of Ripple foods over competitors using comparison data from USDAs National Database for Standard Reference.

![Figure 9: Grams of Protein per serving.](image1)
![Figure 10: Grams of Sugar per serving.](image2)
![Figure 11: Grams of Saturated Fat per serving.](image3)
![Figure 12: Calcium and Vitamin D per serving.](image4)

It's founders; two highly skilled and experienced start up executives have in a few years set up strong distribution networks via Whole Foods and Target stores (Watson E., 2016).

The cost per gallon of Ripple at Wholefoods at June 2017 is $3.50 USD / L, compared to $1 USD / L for standard dairy milk. Although its flavoured milk and sweetened natural milk products taste like existing dairy milk offerings, unless this price point differential changes, it will struggle to achieve the disruption required to alter the existing dairy landscape. The company is relatively new, so their remains a risk that this price convergence could occur in the medium term.
4.3.6 Almond Based Protein with Kite Hill as a case study.

Almond milk is not new. Many wealthy Christians in the middle ages used it as a milk substitute over lent. What makes Kite Hill a disrupter is their ability to use almond milk to make cheeses using enzymes in the same way as dairy milk. This results in Kite Hill cheeses having a very similar taste to milk based products compared to almond paste alternatives. The company does not disclose its revenues, but does have products for sale which when I shopped at San Francisco were about 2.5 - 3 times more expensive than existing dairy cream cheese and cheese products.

The issue with Kite Hill is not in its novel ability to turn almond milk into cheese (which I found to be very tasty). But the price and sustainability issues of using almonds as a milk alternative (Saner, 2015). Accurate research on which milk product has the higher water and methane footprint was difficult to obtain from reliable sources, with large variations in results. UCLA indicates greater water use required for almond milk than dairy milk; however dairy milk creates greater CO2 emissions (Jacqueline Ho, 2016). Good quality research on the environmental benefits of almond milk is crucial for almond milk to be a long term viable alternative to dairy.

For the dairy sector to be disrupted, the disruptor needs to provide a product virtually identical in taste and properties to dairy, be offered at a similar price point and have significantly less impact on the local and global environment. At this stage, it appears Kite Hill can offer the taste and properties of dairy cheese, but it is unlikely that the environmental benefits of almond milk are significant enough to replace the dairy sector outright. I believe Kite Hill (and almond milk) will remain a high value product for people unwilling or unable to consume existing dairy products.

4.3.7 Yeast Based Proteins

Synthetic milk produced by genetically modified yeasts has demonstrated the potential to solve all the issues outlined in other FoodTech products. This may create the greatest implications for the existing dairy sector. Companies such as Perfect Day claim they can develop all the key proteins in milk to make a product with the same taste and properties without components such as lactose and cholesterol. All without the need for cows. Clara Foods make the same claims with egg whites.

The process involves yeast that is imprinted to the relevant DNA of cows. This then undergoes fermentation using food sources such as sugars. This produces the key proteins required for milk. Water and other plant based components are then combined to create a product with a similar chemical structure to products such as milk or egg whites.
Advantages of this process over traditional dairy production are numerous and include (New Harvest, 2017):

- Yeasts consume a multitude of food sources which can be easily varied depending on market demands such as cost. This means input costs of feed could be lower than a typical System 1 New Zealand dairy farmer.
- Because of the yeasts’ processing ability, it only produces milk proteins. Energy is not wasted foraging or inefficient processing such as bovine.
- The yeasts’ can be designed to produce only specific dairy proteins to add value by removing components such as lactose and cholesterol.
- Because the product is highly sterile, its shelf life can be extended.
- Transport costs of getting a finished product to markets can be reduced by locating manufacturing sites close to consumers rather than producers, minimising supply chains.

**Clara Foods – Egg Free Egg Whites**

Clara Foods aim to establish the first commercially viable egg free, egg white substitute. The process involves using yeast to create the proteins found in egg whites (which make up 10 percent of an egg white) and adding water (the other 90 percent) to create an egg white that has similar or superior properties than chicken based egg whites.

Clara foods have stated their goal is to be a business to business (B2B) supplier of egg whites to market. Clara foods aim to achieve this with providing a product that can either be identical to egg whites, or adjusted to meet the specific need of the client (i.e. more “fluffy” for meringues).

To compete with traditional egg white makers, Clara Foods aim to supply a product that has the following advantages (Elizondo, 2016):

- Meets the client’s sustainability goals due to its minimal environmental and ethical footprint than existing chicken based competitors.
- Clients have reduced risk of product recall due to events such as salmonella outbreaks.
- Reduced risk or price volatility as Clara Foods are not susceptible to commodity price variations like existing chicken markets from events constraining supply such as bird flu or feed prices.

The yeast to protein technology used by Clara Foods can be repurposed for other markets as well, namely dairy milk. Because Clara Foods aims to be a B2B supplier of animal protein products their company present a unique position to the existing dairy environment (Elizondo, 2016)
**Perfect Day Foods – Animal Free Milk**

Perfect Day use create milk without cows using genetically modified yeasts (New Harvest, 2017). The company was established in 2015 in Berkleee, San Francisco and has shown rapid progression. The company hopes to release its first products to market in the San Francisco area in late 2017. They have raised over three million dollars in funding to date (New Harvest, 2017).

Perfect Day are still at an early stage of developing their product. Although there are many fundamental advantages to producing milk using yeasts, it remains to be seen if they can develop this product at a similar price to typical milk and more importantly, if consumers are willing to drink a product that has been genetically modified (Watson W., 2016).

<table>
<thead>
<tr>
<th>Feed Source</th>
<th>Dairy Cows</th>
<th>Yeast Based Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grass, TMR, PKE etc.</td>
<td>Sugar, Fats</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process</th>
<th>Dairy Cows</th>
<th>Yeast Based Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typical Dairy Cow</td>
<td>Yeast Containing Imprinted DNA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Products</th>
<th>Dairy Cows</th>
<th>Yeast Based Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Milk, Effluent, Methane Gas, Energy used for foraging</td>
<td>Milk proteins (to be added to other ingredients to form milk substitute).</td>
</tr>
</tbody>
</table>

Table 1: Simplified view of the processes required to make milk using Yeast and Dairy Cows.

Perfect Day currently do not see themselves competing with the existing dairy market directly, however would like to see less factory farming due to market trends created by their product (Fowler, 2017). For example, 75 percent of the world’s population is lactose intolerant, most of these people are concentrated in developing nations (PCRM, 2012). Perfect Day’s ability to create customisable milk proteins provides a unique advantage to existing dairy milk companies in targeting this market, which is three time larger and requires a higher value product than traditional milk markets.
4.3.8 Plant / Lab Based Protein with Memphis Meats as a case study.

Memphis Meats take cells from an animal (Cattle, Chicken and Duck) and then grow these cells in a medium to reproduce to a size that can them be consumed, i.e. a meatball. This process is relatively simple for products such as burgers, mince and nuggets, with the cost of production (currently at $16,000USD per pound), being the large barrier at this stage (Kowitt, 2017). The process required to grow cells to form muscles such as steak and chicken breast is far more difficult (Zuhaib Fayaz Bhat, 2010).

Currently, Memphis Meats use stem cells taken from these animals to make meatballs and large chicken type nuggets. By using stem cells (which reproduce prolifically) as the starter cells, products can be grown quickly compared to using cells that already have a purpose such as muscle cells, as these types of cells often have very slow growth rates (Zuhaib Fayaz Bhat, 2010).

The disadvantage of stem cells is that it is difficult to control what the stem cells will become. They might become muscle cells (a good thing) or bone cells (not ideal). What companies like Memphis Meats are trying to achieve is using the rapid growth rates of stem cells and forcing the cells to become a specific type of cell that can be edible such as muscle cells.

A culture medium is required to supply the cells with the nutrients they need directly. This culture medium and the stem cells are placed into a bioreactor to create products such as mince and nuggets. To create meat products such as steak, there needs to be some sort of edible scaffold that is required to grow the meat into a framework like a steak. This edible scaffold is currently the part slowing down progress in the area, and why most companies operating in this space are unable to move into the more lucrative steak and chicken breast segment rather than mince and chicken nuggets (Zuhaib Fayaz Bhat, 2010).

Memphis meats expect to release their first products in 2020 and have secured 22 million dollars in start-up funding to date (Kowitt, 2017). They have begun to produce chicken and duck with similar structures to the originals. If breakthroughs continue to reduce the cost to build these meat cells, there is significant risk that protein of this type could move into existing meat markets.

Although the impacts of such a disruption would be significant to New Zealand’s sheep and beef industry, there is still concern that the technology will never be able to reach the cost of production that is currently achieved in the sector (Whigham, 2017) and whether consumers will be willing to change current perceptions about eating lab grown meat. Studies indicate that two thirds of people would not eat lab grown meat even if it was commercially available (YouGov, 2012).
4.3.9 **Analysis of the disruptors.**

There appears to be two trends in the FoodTech. The medium-term focus tends to be increasing capital to established plant based start-ups with existing products in the market. These products currently target high value consumers known as conscious consumers, who are willing to pay a premium for products with superior environmental and animal welfare benefits. These products look unlikely to cause significant disruption in the medium term (10 to 15 years) as they are too expensive for the mass market and require scaling of infrastructure and supply chains to get their products priced competitively. None of these products currently offer genuine muscle products.

The greater risk to both the beef and dairy sectors is the development of synthetic foods such as lab grown meat and milk made from DNA imprinted yeasts. These technologies are yet to release products to market, but indicate the potential to replicate the taste and nutrition of milk and meat to the same point as their agricultural counterparts. These companies will still need to release a product to market, establish a trusted brand, supply chains and distribution networks as well as gain regulatory approval before scaling up to a significant level to cause disruption to traditional agricultural markets. It remains to be seen whether these steps can be achieved in practice.

All the products that pose a significant risk to the existing agriculture sector use some sort of genetic modification to achieve the same benefits as their traditional competitor. Consumers, especially high value consumers, are wary of the use of genetic modification in their food source (Future of Food Tech, 2017) this sentiment is further outlined in surveys indicating two thirds of consumers will not eat lab grown meat. (European Commission, 2005). Although this sentiment may change in the future, it creates an obstacle that will need to be overcome. Local meat and dairy producers should be incorporating this issue into strategies to build resilient products.

4.3.10 **Conclusions on falling revenue due to disruption.**

At this stage, there appears to be a large variety of alternative sources for protein available for a consumer, none of which are currently developed to a point that could impact current markets significantly. In the medium to long term, increasing costs of production of existing agriculture products due to compliance costs and future innovations in FoodTech could create significant revenue reductions for meat and dairy products.

Meat producers must also be aware that revenue losses could come from disruption in the dairy sector. Dairy farms are often highly leveraged (DairyNZ, 2017) with more productive soils and climates. A significant disruption in the dairy sector may result in a large land use change to sheep and beef. This could cause an oversupply of these products, effectively causing the same impact and a successful synthetic meat product.
5 RECOMMENDATIONS: METHODS TO BUILD RESILIENCE TO A TRADITIONAL FARMING BUSINESS

Currently, New Zealand's farming systems are some of the most cost competitive in the world against both traditional and new competitors. The likelihood of this continuing in the long term remains increasingly uncertain and should be factored into business decisions across New Zealand's entire dairy and meat value chains.

5.1 At the farm level

5.1.1 Overview

Every farming business will have a different risk profile. Someone who is just beginning their farming career will on average be able to accept greater risk than people coming to the close of their farming career. Quantifying what the business owner's goals are is critical to determine the risk the individual is willing to take to achieve these goals. These discussions should be taken up with a trusted person such as the farmer's accountant or an authorised financial advisor.

After determining the farm's goal, quantifying the risk in the existing farm system should be determined to ensure it matches the farm's goals risk profile. Error! Reference source not found. looks at a suggested method to assess the farm's risk to disruption from a FoodTech innovation. This could be developed further, as more information in FoodTech developments eventuate.

5.1.2 Recommendations at a Farmer Level

I have assumed that most farmers have the bulk of their wealth in their farming operation. This creates significant impacts to their personal wealth if their agribusinesses are disrupted than if the same was to occur to someone with a diversified portfolio of investments. A farmer has many options to build financial resilience into their farming operation if they believe they currently are carrying too much risk.

Selling a section of the farming business to an equity partner or sharemilker.

The advantages of this option is that if the owner operator is able to maintain managing the farm, then they can simply scale down both their debt and equity positions of the farm. The unlocked equity can be used to invest into an off-farm investment that offsets the risk of disruption and can be used as an income source should the farming business become uneconomic. This off-farm investment should not be used as collateral to get its true impact as a disruption risk reduction tool.
Selling the farm to purchase a smaller farm

This option would result in the new farming operation having a lower debt to equity ratio. If land values were to decrease by say 30 percent, which may have been the amount of equity in the old farming operation, there is now still some equity left in the business. This option would not mitigate against a major disruption to the agriculture sector where a technology could cause significant downward trends in asset prices. The new farm may could be easier to diversity should it’s existing operation experience downward trends. Such options include selling land as lifestyle blocks, or conversion to cropping.

The two methods above would suit farming business that have strong balance sheets already that still want the farming lifestyle but perhaps with less risk and the associate reduction in farm income. These are most likely established farmers who are coming to the end of their farming careers. Farmers who do not have the luxury of having a strong balance sheets due to the relatively short length of time they have been in the industry will need to be more creative in mitigating the risks of disruption.

The following options focus on where to spend cash after maximising the free cash flow of the business. Strategies for maximising free cash flow are not outlined as this is outside my area of research. I will mention however that higher cost of production systems often require significant capital expenditures on infrastructure such as feed pads, and increased fencing. Any capital expenditure on farm is most likely achieved by debt, which would decrease the farms resiliency to disruption, or via capital generated from the farm. This capital can then not be used on the following options designed to build resiliently into a farming system. These capital-intensive investments would need to generate good free cashflow in the short to medium term to protect against disruption. This cash could then be applied some of the options below.

Increase equity position of farm

If a farmer is just still relatively young, perhaps the best method is simply to aggressively pay down debt on a farming business. Although there is little risk offset with this method should a large disruption occur, if the farmer is young enough they would still have time to re-enter the workforce in another industry to build up savings for retirement.

Divest in the farming operation into other investments.

My preferred method is to use a portion of free cashflow each year of a farming operation to invest in products that would hedge against a downturn in agriculture in New Zealand. Some options include overseas equities or property. These investments would need to not be used as collateral for the farming operation to truly reduce the farms disruption risk.
The downside of this option is that it is often not as tax efficient as reinvesting back into a capital asset such as a farm. It also reduced the amount of capital available to use to fund growth and expansion of the farming business. These are options that the farmer must weigh up when deciding how much risk they are willing to take on by having their savings in one asset. This option does force the farmer to be much more deliberative with the cash they chose to deploy on the farm as there is less of it. This may in fact lead to better investment decisions and less wasted capital.

**Sell the farm.**

The ultimate divestment would be to sell the farm completely. This option would de risk the farmers financial assets to agricultural disruption but they would need to either find a new place to invest these assets and perhaps a new job to replace the one on farm. This option also missed out on the potential upside of agriculture in the future. There is still a lot of mouths to feed in the world, plenty more value still to capture in New Zealand’s food supply chain for farmers, and the risk of complete disruption is still dependant on the success of a lot of commercially unproven technologies. This could be a good option to consider for people who are close to the end of their income earning potential and about to retire. Diversifying assets from one asset type such as a farm is prudent regardless of the disruption risk of agriculture.

**Recommendations of AgrITech as a disruption risk tool.**

After completing this study, it is my opinion that any expense reduction either through increased knowledge or AgTech innovations in the future will have minimal impact on profitability on farm. This is due to the following points:

- The New Zealand farming system is already one of the lowest cost producers of milk and meat goods in the world (IFCN, 2015) and have less room to decrease than overseas competitors.
- AgTech Innovations currently appear to be better suited to specialised, large scale overseas operators who either produce the feed or feed the animals, not both.

As a result, any investment in AgTech by the farmer should be because it offers a better return on investment than other options outlined above.

The strategies required to add value to milk at a supplier level often take a lot of time to implement. Farmers who begin this transition now will be able to capture value sooner once those products are valued by consumers. Some simple examples include developing good paperwork to track a farms environment footprint using a tool such as Overseer, or beginning the process of breeding cows with desirable traits such as A2/A2 milk.
5.2 At the processing level.

New Zealand’s milk and meat companies are in a unique position where protecting their suppliers is in their best interest as they are often the shareholders of the company. A suggestion for protecting against disruption involves securing a greater percentage of the high value, conscious consumer market that is currently captured. The products sold to these consumers from New Zealand companies must have strong point of differences (POD) compared to their FoodTech offerings.

Such POD’s include:

- **GMO and GE free products:** Even though these innovations may benefit production in New Zealand operations, they will offer greater benefits to FoodTech disruptors. Greater value will be obtained by selling to consumers that wish to avoid genetic modification of any sort.

- **Lab Free / Natural:** Creating a brand that competes against the fact most FoodTech products are often a variety of natural products that are manipulated under heat and pressure will create another point of difference. Pushing the fact New Zealand products come from grass fed, pasture based systems will also add to this argument.

- **Verifiable Environmental Footprints:** People that currently consume meat and dairy do so because the prefer the taste, texture and nutritional benefit over the adverse impacts these impacts have on the environment. Co-Opps will also need to reduce the point of difference FoodTech companies offer over existing competitors such as environmental and perceived animal ethics benefits (health benefits such as lactose free target other markets). These will need to be proven to the consumer with transparent supply chains rather than solely on trusted brands. Any increases in environmental and ethical responsibility by New Zealand farmers will need to translate into more revenue to offset the cost of these measures.

In the future, brands will need to prove the truly unique story that they wish to tell consumers. This can be achieved by leveraging technologies such as blockchain to make supply chains and farm inputs more transparent to the consumer. Reliance on existing high trust, FMCG brands is not enough as consumers become less loyal to established food brands and marketing alone.

If land use changes do start to eventuate from disruption, suppliers could take steps to protect their existing shareholders by protecting entry into Co-Opps if the co-ops brands begin to be saturated by an oversupply of product.
5.3 Final Thoughts

The risk of disruption to an existing farming business system by FoodTech is real, yet difficult to quantify. Investment decisions made on farm need to factor in the possibility that traditional farming may not have the long-time horizons that have been previously assumed by farmers and business professionals alike. This is not necessarily a bad thing, as to succeed in this changing environment, greater strategic and analytical focus will be forced upon both farmers and the food processors alike. Much like the late 1980s agriculture reforms, if New Zealand agriculture emerges from these changes, it will be in a stronger and resilient place than it is today.