KELLOGG
Rural Leadership
PROGRAMME

The Perfect Day

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1. Executive Summary

“If anybody anywhere in the world can use small amounts of energy, water and nutrients to create the same quality food as we can here then why would anyone buy from New Zealand?” That's the question that Lance Wiggs director of several New Zealand high-growth companies (www.lancewiggs.com) asked to his readers back in February 2016. Health, lifestyles, animal welfare, sustainability and environmental concerns are motivating consumers to lean towards milk alternatives. Today, there are many startups (new entrants) from Silicon Valley and from all around the world, creating food innovations every day. New companies are producing traditional agri-food locally, in non-conventional ways using less energy, water, nutrients and pesticides; and are animal-free.

New Zealand dairy companies are focused on producing high quality food and value-added products to keep, and gain more, competitive advantage in an increasingly tough global market. The truth is that without leading edge: agritech, biotechnology, environmentally friendly practices and well supported innovative businesses, it will be very challenging to stay competitive in the decades to come.

The aim of this report is to create awareness around new milk alternatives and to better understand how they could affect the New Zealand dairy industry.

“We can’t afford not to be part of the food revolution, if we are not aware of what other people are doing we can’t be an effective competitor in any market.”

Proudfoot, I. (2017). KPMG.

This report is based on literature review, conversations with people working in the dairy sector and a survey created to assess the general knowledge around new milk alternatives.

Leading the change or being forced to change, that will be a key decision that New Zealand dairy is going to face in the years to come. The dairy industry in New Zealand must embrace new food technology so it could be prepared to take advantage of the new opportunities presented.

The findings and observation of this report are: animal’s milk substitutes like soy, almond, rice, coconut milk, etc. have steadily grown in popularity, although none of these alternatives has been disruptive to the dairy industry. Now, there are game changing new options, improved alternatives to cow’s milk making their way to the markets. Bioengineered milk, plant-based milk manufactured using Artificial Intelligence and milk made from yellow peas are all rapidly rising on the horizon (intriguingly, Silicon Valley’s horizon always seems to be brighter than others). Food-tech startups are attracting a lot of attention nowadays, money is not an issue for most of them, they could potentially disrupt dairy markets globally and change the New Zealand dairy industry as we know it.

2. Acknowledgements

Firstly, I would like to thank my wife Mirna for the time she has allowed, for her patience in what has been a very busy time whilst on the programme looking after our little ones and keeping up with her own job commitments.

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I would like to thank my employer Synlait Milk Ltd. for allowed me to take part in this outstanding course. Special thanks to Brad Harden, I really appreciate what you did to encourage my development. To Phil O'Malley and Tony Aitken my gratitude for your support.

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I must take off my hat to the Kellogg Rural Leadership Programme team, thanks for the opportunity, it's has been invaluable. To Anne, Lisa, Patrick and Scott my recognition for all your efforts.

During this course, I learnt not only about leadership but also about myself and I'm sure the lessons will continue to develop me as an individual and unlock new opportunities in the years to come.

This programme could not happen without the support of the key partners and sponsors and I thank them all for their involvement.

3. Introduction

Full-fat, low-fat or skim? Used to be, there weren't many choices to make over what to pour on your cereal. The global dairy industry is facing a vastly different future. Awareness around nutrition, animal welfare, environment and sustainability is growing. Consumers are looking to become more connected with what they eat.

If anybody anywhere in the world can produce animal-free milk that tastes like the real thing, with very similar texture and nutrients content as cow's milk and it can be used to make many of the numerous products that milk makes, why would anyone buy animal's milk from New Zealand?

We could think that in the next decades most of the people will not stop drinking animal's milk for many reasons, and many people will not switch over to milk substitutes, ever. We could believe that only some people might change and start drinking new milk alternatives. And that will be fine, New Zealand dairy could serve the top end market mainly, people who still wants the real thing: high quality natural cow's milk, from environmentally friendly farms, grass fed cows from New Zealand.
On the other side of the table, we could think that mainstream customers will switch over to new milk alternatives in the next decades, why not? People could drink milk alternatives produced in a more efficient manner, no animals harmed, better for the environment and priced right. And that will be a major, disruptive, huge change.

"Compared with the Industrial Revolution, we estimate that change is happening ten times faster and at 300 times the scale, or roughly 3,000 times the impact. Although we all know that disruptions are happening, most of us fail to comprehend their full magnitude and the second- and third-order effects that will result" (McKinsey Global Institute, 2015).

4. Methodology

The following report is based on literature review, conversations with people working in the dairy sector and a survey. This project was conducted between June and November 2017.

Several forms of literature were revised including: various online articles, opinion pieces, reports and books. Also, TV programs and documentaries were reviewed. (Please refer to references page for a full list). In addition, meetings were held with colleagues and dairy experts to discuss some information and the direction that the report was heading.

Thematic Analysis was used for data analysis. This method helped me to organize and identify meaning across the information studied.

I created an online survey to better know the awareness and perception that people, working in the New Zealand agri-sector, have over new milk alternatives. The survey was sent to 60 people, they had 10 days to answer, 10 questions in total. Before sending the survey was peer reviewed.

In general, I endeavored to create a specific report, primarily using online data and re-using information available when this research was completed.

5. Literature Review and Analysis

Demand for cow's milk has declined over the last few years. Lactose intolerance, hormone and antibiotic use in dairy cows, as well as concerns about animal welfare and environmental conditions have had a negative impact in dairy, globally. More consumers now believe that new milk alternatives are healthier than animal's milk, they are environmentally friendly and sustainable.

Overview

Worldwide sales of non-dairy milk alternatives more than doubled between 2009 and 2015 to $21bn, according to Euromonitor. "We've seen growth for several years now... and we're seeing a shift towards almond, cashew and coconut" consumer trends expert Susan Viamari of researcher IRI said to Financial Times (www.ft.com) in July 16th, 2016.

Since 2011, the vegetarian population has grown by 25% globally, and the vegan population by more than 250%, according to Mintel Global New Products Database (GNDP). These health-conscious consumers are looking for products for every segment of their life that reflect their lifestyle, and beverages are no different.

New research from Mintel in the USA (www.mintel.com) published on April 2016, reveals that sales of dairy milk decreased 7% in 2015 ($17.8 billion) and are projected to drop another 11 percent through 2020.

New Zealand dairy figures

According to the DairyNZ website, the total milk processed by New Zealand dairy companies (season 2015-16) was over 21 billion litres (approx. 2 billion kg of milk solids), mainly for export. Amount of export revenue earnt from dairy farming (2015-16) $12.2 billion.

As stated by Dairy Companies Association New Zealand (www.dcanz.com), the country exports about 95% of its dairy production. Top four dairy export products are: whole milk powder (37%), cheese (12%), skim milk powder (10%), and butter (9%).Protein products, UHT milk, and infant formula accounted for 21% of New Zealand dairy exports in 2015. Added value protein products exports are rising, up from 16% in 2013 (Dairy Companies Association New Zealand, 2017).

Industry structure and profitability

According to Michael Porter, in his book Competitive Advantage (1985), there are five forces that determine industry profitability (see fig. 1).

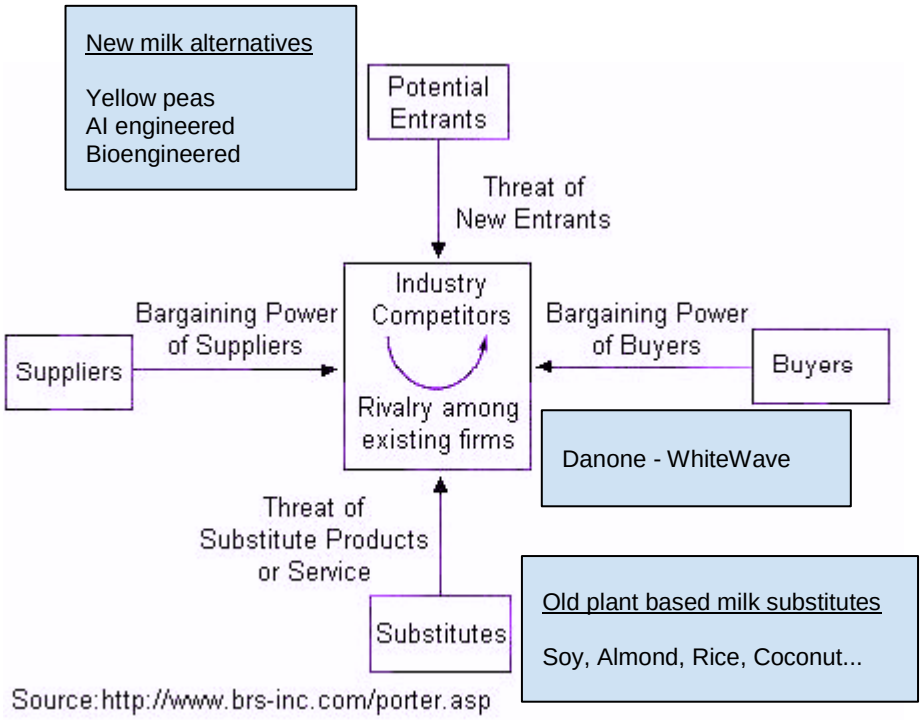


Figure 1. Competitive Advantage Five Forces

The strength of each of the five competitive forces is a function of industry structure. This structure is relatively stable, Porter notes, but can change over time as industry evolves. The industry trends that are the most important for strategy are those that affect industry structure. Focusing on the substitution and new entrants, these threats influence and put a limit on prices that companies can charge.

5.1 Understanding current milk alternatives

So far, many people, many companies, in many countries, have been trying to obtain milk substitutes to replace dairy products, unsuccessfully.
Artificial milk patents have been around since year 1900, but none of them had achieved market success as they use animal's milk derivatives, concentrates (caseins) or by-products to reconstitute what they call "milk".

5.1.1 Old plant-based milk substitutes

There is nothing new about soy, almond, coconut, rice, plant-based milk substitutes production and composition, they are mostly blended products. Soy milk can taste chalky, and soybeans are notorious for being genetically modified. Almond milk, despite its high-protein reputation, has only one-eighth the protein of dairy milk and requires huge amounts of water to produce (Fortune, 2015).
Rice milk has a pleasant enough flavor but is also low in protein. Let's have a look at these milk substitutes' composition, especially protein content, compared to cow's milk (see fig. 2).

Nutrient breakdown, per cup, for selected milk types, both animal and plant-based. Exact amount will vary by brand and formulation.

	Cow, whole	Cow, skim	Goat	Soy, Silk plain	Almond, original	Rice	Hemp, original
Calories	150	80	170	100	60	113	100
Total fat (grams)	8	0.2	10	4	2.5	2.3	6
Saturated fat (grams)	5	0.1	6.5	0.5	0	0	0.5
Polyunsaturated fats* (grams)	0.5	0	0.36	N/A	0.3	0.75	4.8
Protein (grams)	8	8	8.7	7	1	0.67	2
Cholesterol (milligrams)	25-35	5	27	0	0	0	0
Calcium (milligrams)	275	300	327	300	0	283	400
Vitamin A (international units)	395	500	483	501	551	499	500
Vitamin C (milligrams)	0	0	3.2	0	.036	0	0
Vitamin B6 (milligrams)	0.09	0.1	0.1	N/A	.004	0.1	N/A
Vitamin B12 (micrograms)	1.1	1.2	0.17	2.99	0	1.5	1.2
Vitamin D (micrograms)	3.2	2.9	3.2	2.9	2.76	2.4	2
Vitamin E (milligrams)	0.17	0.02	0.17	N/A	0	1.13	1.6
Potassium (milligrams)	320	382	498	300	140	65	N/A

Source: Chicago Tribune, 2009.

Figure 2: Milk Nutrients Breakdown

As we can see on the table above, most of the plant-based milk substitutes are less nutritious than animal's milk, they provide much less proteins (apart from soy milk).

5.2 New milk alternatives entrants

Three new entrants have been identified in this report with the potential to change the dairy industry structure, and they could possibly influence profitability.

5.2.1 Bioengineered milk

Genetically engineered milk or bioengineered milk, is being produced from yeast that have had changes introduced into their DNA using the methods of genetic engineering to produce milk proteins.

Biotechnology and genetically modified organisms - from insulin, to tomatoes, to milk.

In 1978, an emerging biotechnology company named Genentech produced the first synthetically manufactured insulin that could be made in large amounts. Using bacteria or yeast as miniature "factories," the gene for human insulin was inserted into bacterial DNA. The result was human insulin, called recombinant DNA insulin, which did not cause the problems that animal insulin sometimes did. When it became widely available in the early 1980s, this new insulin changed the treatment of diabetes forever. Today, people with diabetes who require insulin use a form of recombinant human insulin rather than animal insulin (Wikipedia, 2017).

Commercial sale of genetically modified foods began in 1994, when company Calgene from California USA first marketed its unsuccessful Flavr Savr delayed-ripening tomato.

Perfect Day Foods

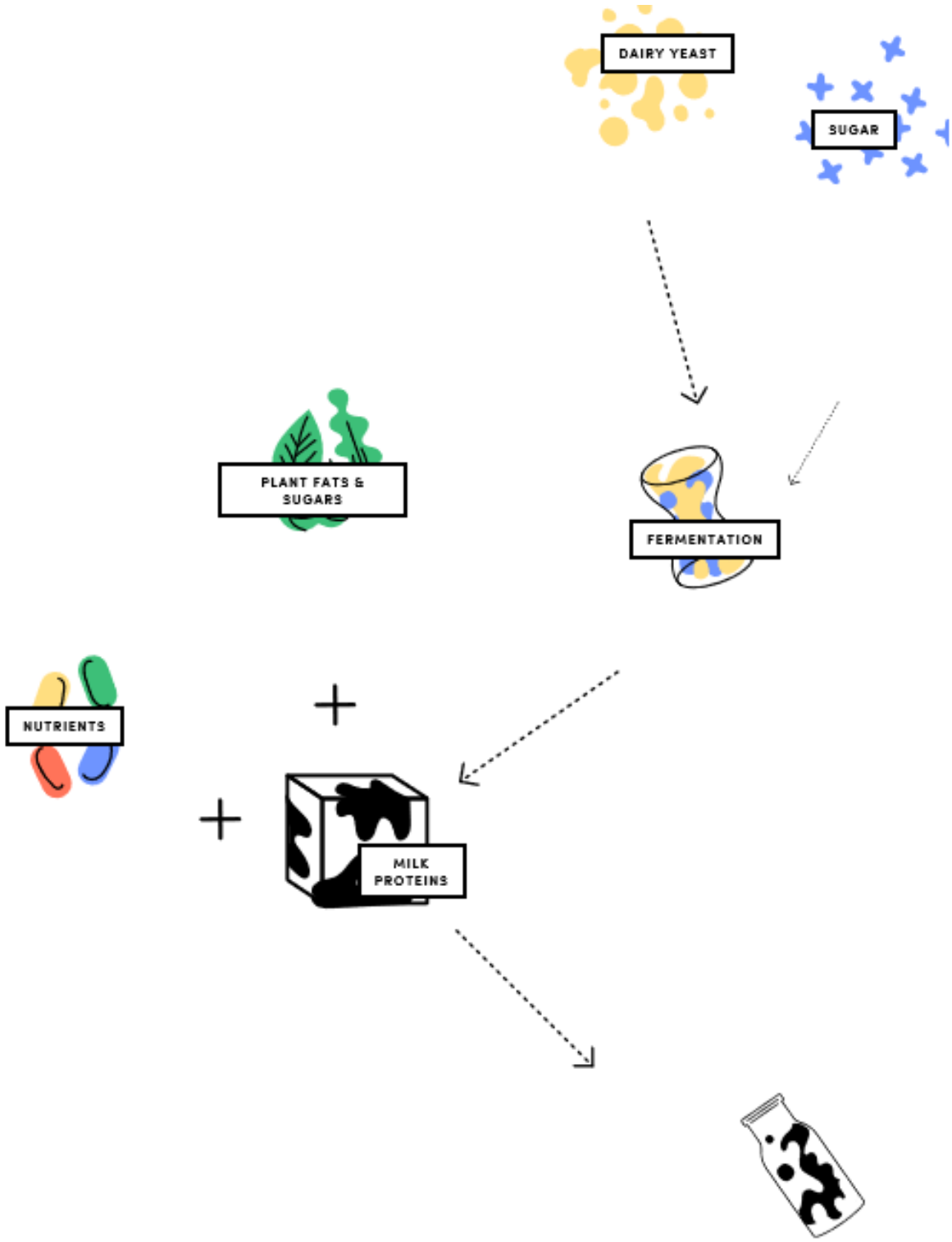
Perfect Day Foods is a San Francisco based startup company producing bioengineered milk who is planning to join the milk alternatives club later in 2017. According to the company's website (www.perfectdayfoods.com), this milk alternative will have exactly the same casein and whey proteins as cow's milk (with the advantage of using only A2 proteins). This milk is a ground-breaking innovation, with much more potential than the rest of the current alternatives.

Bioengineered milk process overview

Bioengineered milk is made from real milk proteins combined with plant-based (lactose-free) sugar, healthy plant fats, vitamins and minerals (see fig. 3). It has the potential of having the same taste and texture as cow's milk, with no food safety or contamination concerns.

Perfect Day Food developed dairy yeast that can produce milk proteins. The company receives a standard yeast from the United States Department of Agriculture (USDA) to ensure that it is safe and well-understood. Once the yeast is received, they provide this yeast with a "blueprint" that allows it to ferment sugar and create real milk proteins. This is the very same blueprint, in the form of DNA that cows use every day.

“Our yeast, which we lovingly call Buttercup, is now a milk protein-making machine that’s 100% food-safe. Our proteins are made in a process akin to craft brewing, using fermentation (we call it “yeast farming”). This process is much cleaner and more resource-efficient than animal farming, and it’s the cornerstone of our new approach to dairy” (Perfect Day Foods, 2017).



Source: Perfect Day Foods, 2017.

Figure 3. Bioengineered milk process

In 2016, Perfect Day Foods have managed to raise funding and they have received support from SynBio, Axlr8r, and Hong Kong's Horizon Ventures who backed the Impossible Burger and Spotify, to name a few (Think Walden, 2016).

Currently, the company's bioengineered products couldn't match on cost compared with animal's products. Perfect Day Foods is planning to begin production with a range of niche yoghurts and cheeses until their cost of production comes down.

Inclusion of casein

There have been several issues raised with bioengineered milk. One of the problems is with casein controversy, with questions of whether the product can be considered truly vegan whilst it contains this protein. Generally, casein is not considered vegan, as it is isolated from animal products, making it a highly profitable by-product of dairy farming and therefore essential for vegans to avoid.

Perfect Day Foods notes that the casein in their items is developed with yeast instead of cows. Thus, while some may continue to argue that the product isn't vegan, others should accept it given that in this case it is no longer technically an animal product, as it is derived from other methods.

Genetically modified yeast

This product may also cause concern with those who are less keen on GM foods, as the yeast used to make proteins have been genetically engineered. What is important to note however, is that you don't eat yeast; it's just the culture it produces which is harvested and consumed.

"If we want the world to change its diet from a product that isn't sustainable to something that is, it has to be identical [to], or better than, the original product" Perfect Day Foods founder Gandhi says. "The world will not switch from milk from a cow to the plant-based milks. But if our cow-less milk is identical and priced right, they just might" (National Geographic, 2014).

5.2.2 A brand new improved peas milk alternative

Ripple Foods (USA) created a plant-based milk innovation made of yellow peas, that is high in protein when compared with other alternatives (U.S.News, 2016). This milk alternative has a creamy and smooth flavor, as described for people who already tried it. This product, as September 2017, is currently available in many of the main food retailers across the USA.

Ripple is producing a milk alternative that is free of soy, lactose, gluten, GMOs, and carrageenan. The company is using a patent-pending method to harvest ultra-clean protein from peas, removing the impurities that give other plant-based milks their beany flavor and chalky texture. With 8 grams of protein content, eight times the protein of almond milk and half the sugar of milk.
What makes Ripple's milk alternative more tempting is that it comes with optional flavors: original, unsweetened original, vanilla, and chocolate varieties.
Other nutrition facts: one serving has 32mg omega-3s from algal oil and 45% of daily value for calcium with 75 to 145 calories per cup (Ripple Foods, 2017).

But consider how long it took Ripple Foods to research and develop this new product and make it available for sale on the main USA retailers' shelves. How fast is this kind of innovation happening these days?

The founders raised several million USD in 2015 (from Google and other undisclosed investors) and Ripple's main products were launched early in 2016. But the founders are not some kind of millennials cowboys from Silicon Valley. Here is some background to the two-key people to help us understand the kind of game they are into:

Ripple co-founder Dr Neil Renninger, who holds a Doctor of Philosophy degree in Chemical Engineering from the University of California, Berkeley, co-founded Amyris, a biotechnology company that developed technology capable of creating microbial strains to produce artemisinic acid — a precursor of anti-malarial drug artemisinin. After Amyris, Renninger focused on developing processes for converting plant sugars into fuels and chemicals as part of a wider mission to combat climate change. "Ripple is an extension of that desire for impact, disrupting an industry that is one of the most significant emitters of greenhouse gasses and utilizers of water" reads his bio on the Ripple Foods website.
Co-founder Adam Lowry, also has experience with the venture capital industry after co-founding Method Products, an environmentally friendly home cleaning products company, in 2000. Lowry has also worked as a climate scientist at the Carnegie Institution for Science, where he developed software products for the understanding of climate change and serves on the board of AeroFarms, the urban agriculture company. He holds a Bachelor of Science in Chemical Engineering from Stanford University (AgFounder News, 2015).

"What we did is use technology to create really good food," reported Lowry to Bloomberg (www.bloomberg.com) in September 13th, 2017. "The world has recognized that we need to go more plant-based. But most plant food sucks, particularly in the alternate dairy space. It's low in protein, thin, and chalky"

Why yellow peas?

Using Renninger's technology, they began to experiment extracting protein from different plants that had a notable amount of the biomolecules. "You name it, we screened it," says Renninger. Most of them tasted terrible. Then the pair tried yellow peas, which are

inexpensive to grow and don't yield a strongly flavored product. The result was a drink that has a hint of concentrated powdered milk taste and a smooth, creamy texture.

"It's not that we have the only pea milk on the market; what makes us unique is that, thanks to technology, we have the purest plant protein in the world" says Renninger (Bloomberg, 2017).

5.2.3 Artificial Intelligence engineered plant-based milk

A Chilean company called NotCo (www.thenotcompany.com) is using Artificial Intelligence software to replace dairy products with vegetable-based ones. These new products are packed with the same, or better, taste than traditional dairy products and they have similar nutrient contents.

This company has recently participated in a demo day in San Francisco (USA) organized by biotech accelerator Indie Bio. The accelerator picks out promising startups and helps provide them with the training and funding they need to bring their products to fruition. Also, this Chilean based startup now has strong support from Silicon Valley.

"Artificial intelligence gives us a new way of understanding our food. The incredible thing about the computer is that it has no bias: which implies that Giuseppe (the name of the software) is able to combine a broccoli with a goji a mushroom and a walnut served to emulate the taste of a chocolate, or to use lupine to replace the egg in a mayonnaise. The use of this technology allows us, for example, to discover new sources of food, which for centuries has been ignored by humans. New sources of fiber, calcium and proteins from the plant kingdom are some of the things they have managed to identify with Giuseppe and make him the most intelligent food scientist in the world" (TheNotCompany, 2017).

The machine learning software uses deep learning parameters to understand food at a molecular level, helping the team to deliver tasty and affordable nutrition while using less water, less land, less energy, and without the need of animals.

It's a complicated process, as described by company founder Matias Muchnick, but it's designed to understand human perception of taste and texture. This process allows to suggest clever recipes for sustainable and tasty plant-based foods. Artificial Intelligence even understands the availability and use of resources for every single plant in the company's database.

The Chilean company currently sells an eggless mayonnaise called "NotMayo" in several countries in South America and plans to launch in North America stores, including Walmart, in 2019.

"I'm not typically a fan of mayo but this stuff was delicious"

Brodwin, E. (2017). Business Insider Australia.

The startup also has plans to roll out its next products, which include vegetarian yogurt (“NotYogurt”), cream cheese (“NotCheese”), and milk (“NotMilk”) in the next few months.

“No longer based on animal ingredients, this is a food entirely based on plants - although it looks and tastes like the classic food”

Newman, L. (2017). Aljazeera.

6. The Future of Milk Discussion

The debate about the future of milk is a very hot topic these days. Will new milk alternatives disrupt the dairy industry? Diverse opinions and perspectives open a discussion in this matter pretty much every day. In this section, we will have a look at companies and people's different views.

Milk alternatives global escalating interest

Health, lifestyles, animal welfare, sustainability and environmental concerns are motivating consumers to lean towards milk alternatives globally. The emphasis on plant content reinforces the growing interest in vegetarian and vegan products. The escalating interest in so-called "flexitarian" lifestyles was observed by Mintel's 2016 Global Food & Drink Trend Alternatives.

Mixed opinions about new milk alternatives

Here in New Zealand, Fonterra does not see artificial milk as a serious threat to the dairy industry. Fonterra sees the task of replicating cow's milk on a large scale as too complex, research and development director Jeremy Hill pointed back in 2014. "There are hundreds of different components in cow's milk. To even try to duplicate this using yeast requires genetic modification and even then it is unlikely that artificial milk will be able to match the real thing", Hill said (Stuff, 2014).

Former MPI Minister Nathan Guy sees the development of bioengineered milk as an "interesting innovation" for those who were lactose intolerant, but he believes most consumers would still select the traditional variety. Victoria University researcher Jason Young, of the Contemporary China Research Centre, believes there would always be a market for milk from New Zealand dairy cows. "All through Asia, you can see there's a growing market for green food products - a move away from having a lot of additives and too much processing - and organic food" (Stuff, 2014).

Philip Tong, director of the Dairy Products Technology Center at Cal Poly in San Luis Obispo, California says: "The 20 or so components of Perfect Day Foods (USA) barely scratch the surface of milk's complex chemistry. We've been milking [cows] for seven or eight thousand years. I doubt biotechnology could fully reproduce what Mother Nature intended" (National Geographic, 2014).

The above views are well supported and many people share the same opinion. However, 3 years after these affirmations were made, things have changed. Bioengineered milk will be launched to the public any time soon. This alternative is claiming to have the same attributes as cow's milk. Also, there are more milk substitutes innovations coming soon.

Perhaps, we should consider how close new milk alternatives will get to the real thing. Will animals' milk be replicated? The answer could be… never, not 100%. But substitutes don't have to match exactly the real product, just only close enough so people like it and buy it, when priced right. Synthetic or wool carpets? We all know how the story goes.

What's considered milk?

The dairy industry in the USA is demanding that the Food and Drug Administration (FDA) define and enforce what is considered "milk". Federated Farmers of New Zealand dairy chairman Andrew Hoggard, has claimed milk alternatives shouldn't be called milk (also the survey on this report showed many people sharing this view). Hoggard also pointed that the name "milk" should be used only for the milk that comes straight from a mammal.

On Ripple Foods website, you can play a game called: What do you think milk should be? But, before you can start the game, you will find this words on the screen:
Dear dairy, I can understand why you are upset. Almond milk is a sham. Only 1g of protein and less than a handful of almonds in an entire bottle? That's not milk. Cashew and coconut milk are even worse; they don't have any protein. But you want to define milk as: a lacteal secretion from a mammal. Really?! Ewww! "Hey Mom, will you pour me a cold glass of lacteal secretion?!" C'mon, we can do better than that (Ripple Foods, 2017).

Regardless of what to call it, milk alternatives will make their way to the markets whether we like it or not. Because of this, I think there is no point in trying to own and rule how people can and want to define milk.

The not so optimistic perspectives for the New Zealand dairy industry

Some people do not believe in a bright future for the dairy industry in this country. Journalists, Scientists and other professionals are expressing a not so optimistic view regarding the future of the New Zealand dairy industry. Below are some opinions:

"The big questions to ask ourselves here in New Zealand is what are we doing to stay in the race? And with technology, science, R&D, Venture Capital accelerating and converging at such exponential rates blowing the traditional pasture based model of agriculture out of the water, how does New Zealand compete? Sorry to rain on anyone's parade, but smart farming and food innovation based on pasture based milk products do not count" (Rosie Bosworth, 2016).

"I have gone on record many times trying to alert the New Zealand dairy industry to the risks we face from milk containing A1 beta-casein. To a significant extent, it is these

beta-casein issues that are opening the door for plant-based synthetic milks. From a dairy industry perspective, I have major concerns as to how that is now going to play out. The emerging franken-notion of milk grown in an artificial udder, constructed from stem cells, and supported in a laboratory environment, is far too many steps along the franken-food pathway for me to be comfortable. It may indeed be feasible in the not too distant future and it will be biologically efficient. There will be no greenhouse gases, no urine and no poo. But social acceptability will be another issue" (Keith Woodford, 2017).

New Zealand dairy industry is amongst the best in the world. But this industry must stay competitive and become the most sustainable farming business, embracing new food technology. Having a master plan, a strong strategy, will be essential to set out a clear vision and ambition for the future of the industry. Collaboration and innovation facilitated by the government, organizations and people, will play a key role in determining how to make the dairy sector sustainable.

Disruptive to the New Zealand dairy industry?

"Disruption describes a process whereby a smaller company with fewer resources is able to successfully challenge established incumbent businesses. Specifically, as incumbents focus on improving their products and services for their most demanding (and usually most profitable) customers, they exceed the needs of some segments and ignore the needs of others. Entrants that prove disruptive begin by successfully targeting those overlooked segments, gaining a foothold by delivering more-suitable functionality—frequently at a lower price. **Incumbents, chasing higher profitability in more-demanding segments, tend not to respond vigorously.** Entrants then move upmarket, delivering the performance that incumbents' mainstream customers require, while preserving the advantages that drove their early success. When mainstream customers start adopting the entrants' offerings in volume, disruption has occurred" (Christensen, 2015).

Because disruption can take time, incumbents frequently overlook disrupters, Christensen notes. Disruptive innovations are made possible because they get started in two types of markets that incumbents overlook. *Low-end footholds* exist because incumbents typically try to provide their most profitable and demanding customers with ever-improving products, and they pay less attention to less-demanding customers.
In the case of *new-market footholds*, disrupters create a market where none existed. Put simply, they find a way to turn non-consumers into consumers.

Today, new milk alternatives companies are offering mostly products in the value-added segment and turning many non-consumers into consumers. Ripple Food is offering a premium milk substitute in the USA, almost at double the price compared with plain cow's milk. TheNotCompany is selling NotMayo (a mayonnaise alternative) in South America. Perfect Day Foods is planning to launch a bioengineered cheese soon in the USA.

These companies producing new milk alternatives have a common belief / target: they will work very hard until the cost of production comes down and they would eventually become cost competitive.

Is Infant Formula the panacea?

The Infant Formula business in New Zealand has been gaining momentum over the last couple of years. Investments in state of the art Infant Formula plants, all around the country, are showing that companies are moving fast offering products for export in this lucrative market segment.

Infant Formula composition, in average, has about 25% more or less milk. The other 75% is made of additives, vitamins, oils, etc. These additives, mostly, are coming from overseas. A key aspect here is that we should be able to understand for how long New Zealand dairy companies are going to be able to maintain their competitive advantage in this market. It is very important to keep in mind that most of the Infant Formula's additives are not produced here in in this country and animals' milk could be replaced for a suitable alternative elsewhere in the future.

Asking the right question

"If I had an hour to solve a problem and my life depended on the solution, I would spend the first 55 minutes determining the proper question to ask, for once I know the proper question, I could solve the problem in less than five minutes."

Albert Einstein.

Over the last few weeks, I have had the chance to talk to many people working or related to the agricultural sector in New Zealand. There is a common question that, the majority of us, we have been trying to answer: Will consumers change their habits in the future and prefer artificial milk and its derivatives over cow's milk and products? Is this the right question to ask? Are we directing this question to the right audience? Should I ask my daughter (4 years old) and my son (1 year old) if they are willing to switch over to these new products when they grow up?

The next generation should have the answer, they will or they will not prefer new milk alternatives, but now we can only make our best guess.

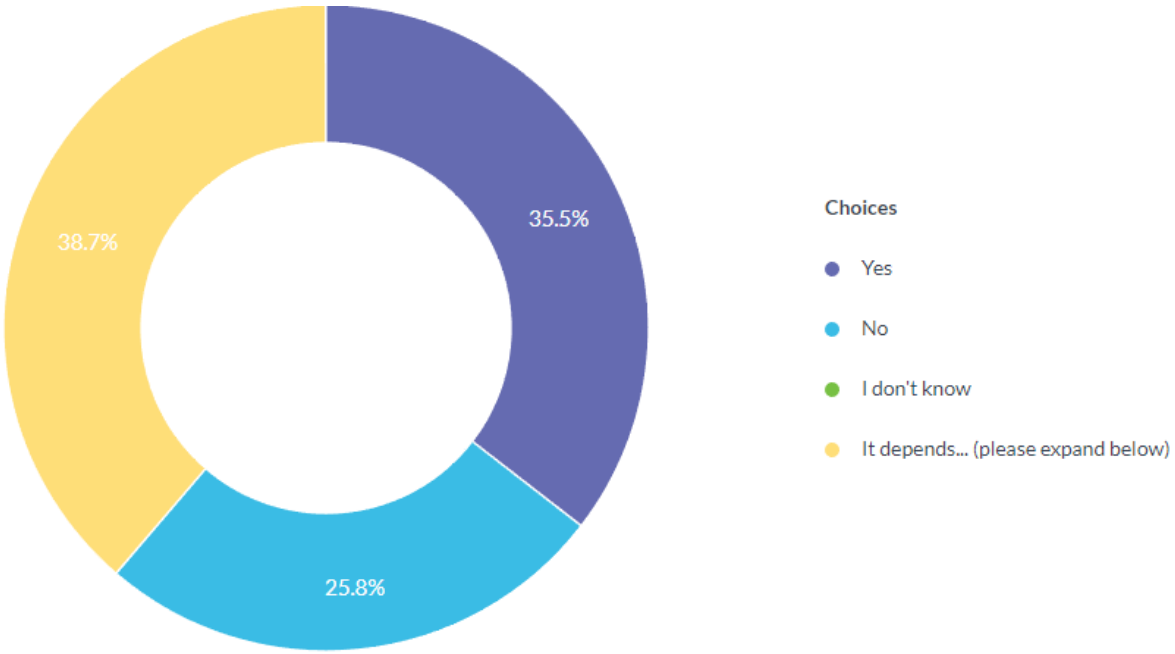
7. New Milk Alternatives Survey

When trying to understand the impact that new milk alternatives could have in the New Zealand dairy industry, I realized that even people working in this industry, colleagues and managerial levels don't have a good general knowledge about new milk alternatives and potential competitors. I created a survey to better know the awareness and perception that people working in the New Zealand agri-sector have over new milk alternatives.

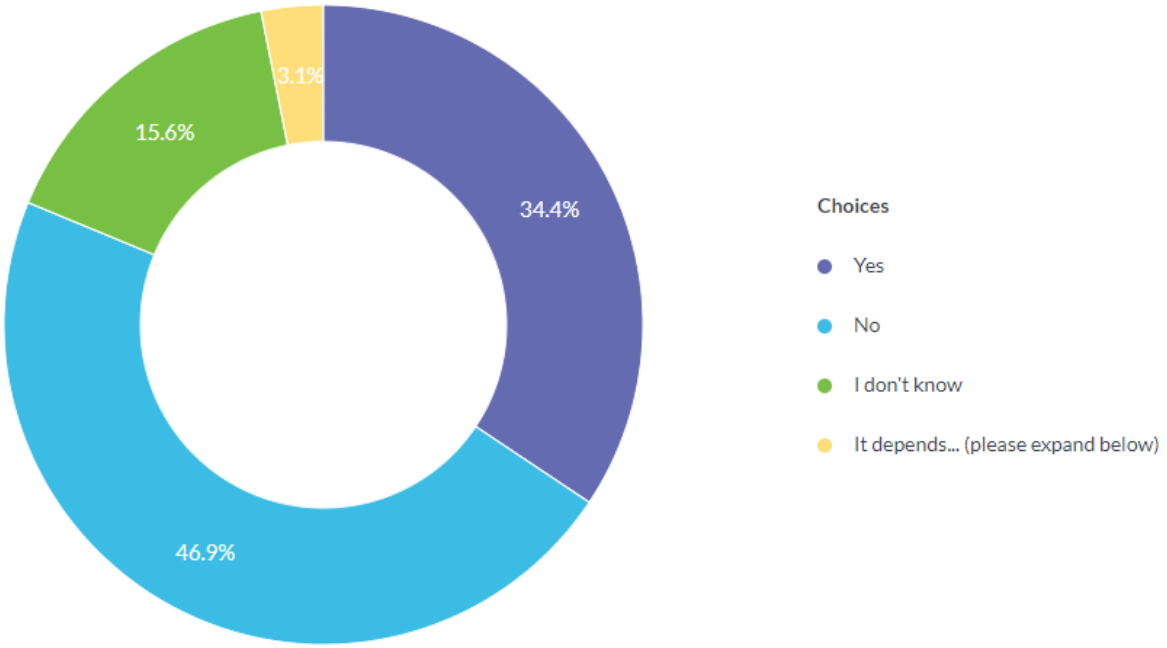
Survey responses

Results from 38 respondents. (see expanded responses in Appendix 1)

Q 1 - Milk alternatives like soy, almond, coconut, and pea or rice milk: are these a kind of artificial milk?



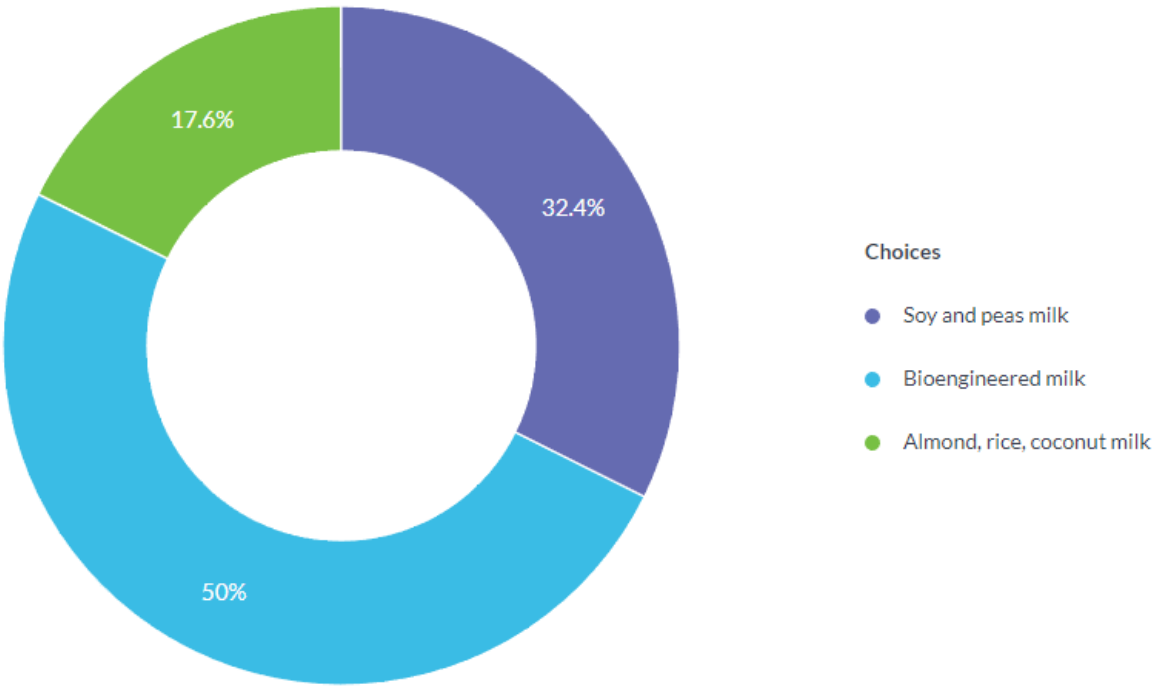
Q 2 - Artificial milk and bioengineered milk, are they synonymous in your own view?



Q 3 - In your own words, how would you roughly describe artificial milk?

About 60% of respondents describe artificial milk as a product that doesn't come from a mammal. Others said: "not a natural product", "synthetic", "made in lab", "plant-based".

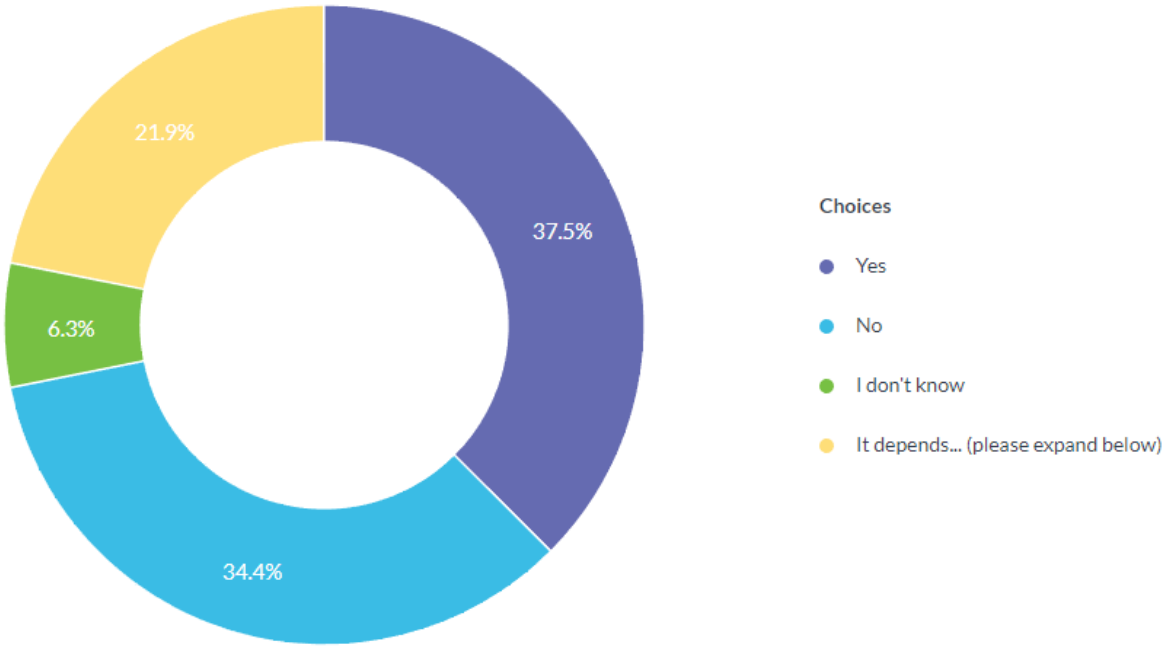
Q 4 - Which milk alternatives do you think provide approximately the same protein content in grams as cow's milk?



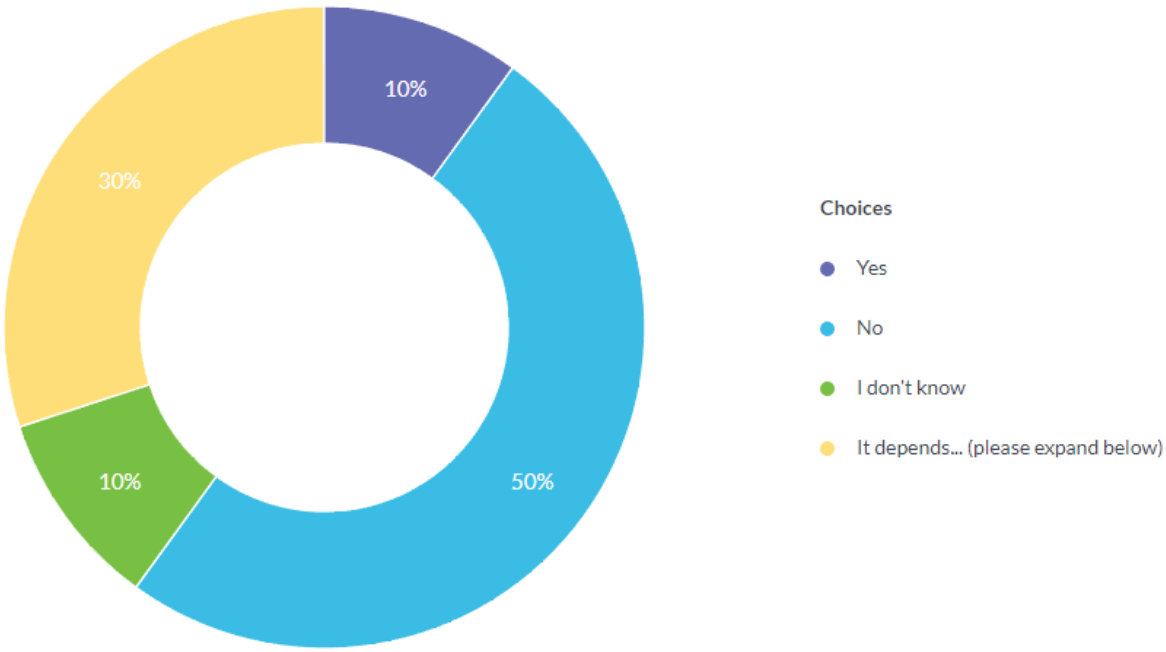
Q 5 - From your experience, can you explain basically what “genetically modified” means for you in terms of food?

According to 70% of respondents, it means: Food source that has had its genes edited.

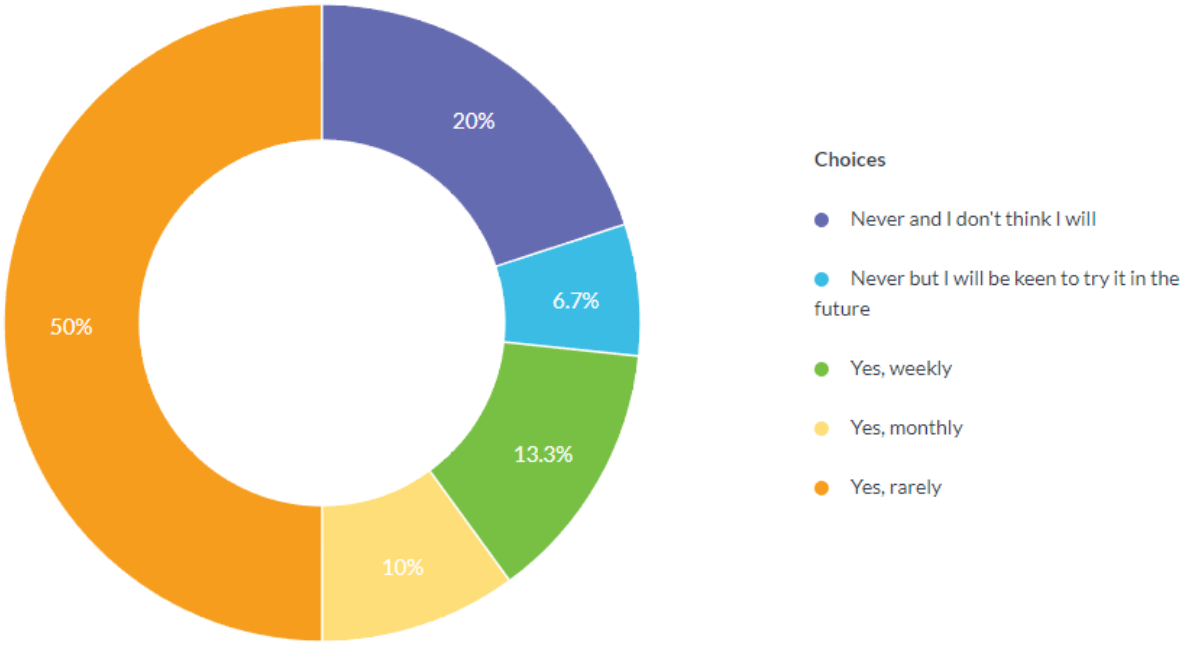
Q 6 - Do you think bioengineered milk is a kind of “genetically modified” food?



Q 7 - A vegan person doesn’t drink animal’s milk. A bioengineered milk alternative utilizes cow’s DNA to produce lab-made milk. Could a vegan person drink this milk?



Q 8 - Have you ever purchased any milk alternatives?



Q 9 - Milk alternatives total sales are growing globally. In your own words, why do you think is this happening mainly?

The most named cause according to 60% of the answers is the perception that milk alternatives are "healthier". Other reasons are: food trends, environmental impact, sustainability, price, diet changes, a growing population, animal welfare, more alternatives available.

Q 10 - If in the next 10 - 20 years milk alternatives can match the price, nutritional value and taste/texture of cow's milk, do you think the next generation could switch over to this product?

About 35% of respondents think "Yes, definitely" the other 65% said: "Probably", "Many consumers will" and "Yes, but… transition will be very slow… there will always be a market for natural products".

The meaning of the survey results

There is no clear consensus and understanding among people, working in the New Zealand agri-sector, about artificial milk or bioengineered / genetically modified milk. People must find more information and be aware of milk alternatives.
Interestingly, half of the respondents said they have already tried milk substitutes, about 20% said they will never try milk alternatives.

Respondents are not too sure about protein contents, either from cow's milk or from substitutes.

Almost all respondents have no doubt that the dairy market will shrink in the future. Also, they think is highly possible that future generation mainstream customers will switch over to new milk alternatives, if certain conditions are met. Reasons being that there is an increasing perception that new milk alternatives are healthier than animal's milk, they are environmentally friendly and sustainable.

8. Conclusions

State of affairs

Concerns over lactose intolerance, hormone content, antibiotic use in dairy cows, as well as questions on animal treatment and environmental conditions have all weighed on milk's demand. There is a growing perception that new milk alternatives use a fraction of the water compared with traditional dairy farming, they don't produce greenhouse gas emissions and are becoming cheaper. These conditions are making milk alternatives more attractive to the growing numbers of consumers.

Despite the increasing consumption of milk alternatives, a niche for premium milk and its derivatives — at premium pricing — has been gaining traction, reflecting some consumer preferences for wholesome foods.

Moving fast

According to the Dairy Companies Association New Zealand, dairy commodities, whole and skim milk powder, account for approx. 50% of total exports and a grand total of about 70% including cheese and butter in 2015. Many New Zealand dairy companies are moving towards the added-value proposition and they are less enthusiastic about selling commodities. We could think that most of New Zealand dairy companies will try hard to capture the best part of an increasingly demanding market. Companies will continue to produce more and more value-added products for a market hungry for New Zealand top quality dairy products. If continuing with this trend, how long it could take to New Zealand dairy companies to shift the majority of theirs commoditized products (over 50% today not including cheese and butter) to the value-added side proposition?

But it is not all about focusing in value-added products. When talking to Mike Petersen (New Zealand Special Agricultural Trade Envoy) last September in Wellington, he pointed out that many countries are charging increasingly high taxes when importing value-added dairy products from overseas, leaving dairy exporter companies with much less profits.

As Reed Hastings, the CEO of Netflix, noted (right as his company was making the leap from DVDs to streaming in 2011), most successful organizations fail to look for new things their customers want because they're afraid to hurt their core businesses. Clayton Christensen called this phenomenon the innovator's dilemma (Christensen, 1997). Hastings simply said, "Companies rarely die from moving too fast, and they frequently die from moving too slowly" (McKinsey Global Institute, 2016)

How fast, and smart, the New Zealand dairy industry can move in the near future will be critical to staying competitive over the next 10-20 years.

9. Recommendations and Final Words

Awareness and proactive approach

In the making of this report and when the “new milk alternatives survey” was finished, it was very clear to see that many people working in the New Zealand agri-sector don’t have a clear understanding and knowledge about what is happening around the globe regarding new milk alternatives.

Insightful awareness of new food technologies and bioengineered innovations will allow the New Zealand dairy industry to stay competitive and to take advantage of potential opportunities.

Competitors’ strategies must be analyzed and weighted, like the one from the French giant Danone. On April 12th (2017) Danone completed the acquisition of WhiteWave, an American company who manufactures, markets, distributes, and sells plant-based foods and beverages, coffee creamers and organic products.

New Zealand dairy companies need to reconsider their approach to the threat presented by new milk alternatives. Organizations must be proactive and evaluate the creation of counter disruption strategies. New Zealand could become a leader plant-based beverage protein producer. Therefore, companies will continue dominating the world of milks while improving environmental practices.

I entirely agree with Sir Peter Gluckman (Prime Minister's chief science adviser) when he said: “New Zealand could stay focused on what it currently produce, remain GM free and grow high-end natural ingredients for synthetic foods made overseas, or invest in a full product chain and make the products here" (Stuff, 2017)

"Eight years ago, I was laughed at [synthetic milk]. Now I think the risk is real"

Sir Gluckman, P. (2017). Prime Minister's chief science adviser

The next chapter

The New Zealand dairy industry must be able to jump onto the next leap, leading R&D and using all resources available. More importantly, government, organizations and investors must provide launching platforms and support for innovations to occur. Therefore, we will have new products coming from New Zealand companies, incumbents or new entrants.

Will cow's milk taste, nutrition value and texture be replicated? Well... the truth is that we really don't know, yet. Perhaps, the day will come in the future where people could "design and make their own" kind of milk at home, using an "artificial udder" device. This could give people the option to choose from different flavors, with the desired taste, texture and temperature, able to select the nutritional value they want, and more.

Regardless of what will happen over the next decades with milk alternatives around the world, things are not going to be the same for the New Zealand dairy industry. The rising appetite for new milk alternatives is creating threats and opportunities that need to be discussed now, so we can prepare one of the biggest industries in the country for the next 10 to 20 years.

"There are many examples of substitutes or blends on the market now (margarine, artificial sweeteners, non-dairy creamers etc.), which consumers seem to trust and readily accept. While the initial reaction is currently 'yuck', it could become 'who cares' over time which would give synthetic food a free license to infiltrate the food chain"

Fowler, R. (2016). New Zealand dairy farmer

The dreamer

I believe in a "perfect day" in the future, where New Zealand is the best premium producer of milk and its derivatives. A kind of milk that took the best out of the A1/A2 casein debate, a milk that is antibiotic free and has solved the lactose intolerance issue with innovation.

I believe in a day when the whole country is proud of the way that milk producers look after the environment and the way animals are treated.

A day when consumers all around the globe want to pay premium price to buy New Zealand milk, they love it.

A kind of milk produced here in New Zealand, sourced from animals, or plant-based, or bioengineered, or a combination of all of them. Let's rather lead the change than being forced into it.

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11. Appendix 1

New Milk Alternatives Survey – All expanded responses

Q 3 - In your own words, how would you roughly describe artificial milk?

Artificial milk is any substance resembling or claiming to be milk, but not having its original source as the mammary gland of a mammal.

Looks & feels like milk but not from a mammal.

I would not describe it as artificial but an alternative source of nutrition in contrast to the milk we have previously sourced from dairy

Plant based

Milk created within a lab environment without the need for animals and with perceived less impact environmentally.

Milk that is not a naturally made product and produced by a mammal

A white fluid that does not proceed from mammals but has similar constitution and that's marketed as "milk".

Milk not produced by cows, goats or sheep

A product not harvested from the mammary gland of a mammal that is marketed as milk, or had a similar appearance and use as milk

Any milk product not secreted by a female animal!

Milk produced from a non-mammal source

Milk not produced from an animal.

Product which synthetically replicates the nutritional and physical properties of cow’s milk

Artificial milk is something that is not a natural product.

Milk made in a laboratory to be as close as biologically possible to natural milk

A milk product that has been altered significantly from the raw milk produced from animals

Milk that is synthesized without using plants or animals as the source of raw material.

Made from chemicals?

Something that has been made to look /taste/ feel like milk but has been manufactured from an unrelated base. i.e. engineered vs juiced

Depends on what it is - if soy milk, etc., it is juice, not milk If bioengineered, it is synthetic product, shouldn't be called milk

Milk replacements - natural or synthesized

Milk product produced synthetically

Any milk that does not come from a mammal

Milk that doesn't naturally come from a mammal

Laboratory made by adding together separate components

Made in a lab. Not requiring refrigeration and with much longer shelf life. I believe it is derived from a yeast.

Produced from an alternative source, changed from its natural state to act, taste, look like milk

Milk artificially made by technology

Milk that is chemically the same as 'true milk' but was made in vitro

Milk you need to make, i.e. powdered milk

Milk manufactured through a process rather than coming from an animal, but still meeting all composition requirements that class it as milk.

Artificial Milk is milk not from a mammal, cow, sheep, goat etc. Artificial milk is all others soy, almond, pea, etc. these shouldn’t be called milk at all really. Synthetic milk is cultures or lab grown etc.

Raw product not taken directly from a cow

Genetically modified - not from a natural source

Formed in a lab through cross genetics of different products.

Changes made to a part of the genetic structure.

Q 5 - From your experience, can you explain basically what “genetically modified” means for you in terms of food?

Genetically modified is where the genetic sequence of the organism producing the product has been modified to create a different expression of the gene - where that modification has been achieved artificially 9in a lb.), as opposed to via natural selection or cross breeding.

The genes have been altered / removed / spliced in / turned off or on, in a lab to express chosen characteristics

Where the DNA has been modified or altered to produce a different end product

Changed by science, selectively engineered

The changing of something that would not normally occur naturally

There has been some alteration/manipulation or altering of the genes of the animal/plant to create a product that would not have occurred naturally in the environment

For me, a "genetically modified" thing is a product of HUMAN alteration of genes (DNA).

Food that is produced using cells were tampered with in a laboratory

Something that has had its DNA edited, add/delete genes

Altering the genetic make up to get a desired outcome e.g. bigger, better, smoother, etc.

GM refers to the plants and that their genome has been modified to incorporate some beneficial trait that is not available naturally in the genetic pool for that species. These plants don't differ in my view on the impact it has on my food.

Food sources that have been modified to increase production or a specific trait in the food (i.e. marbling steak)

Product from a plant or animal which has had genes modified in a lab to produce particular useful traits

Something that has been changed from the way it would naturally exist. It doesn't necessarily mean that those changes couldn't have occurred through a breeding process but it certainly speeds up that process.

GM is food grown or produced from a plant or animal that has been bread using genetic modification techniques in a laboratory

A laboratory altered produced alternative of its original self i.e it was not produced in the natural environment under natural conditions where nature taken its natural course

In my view, the term genetically modified is the super set of all techniques used to modify the genetics of a food (in this case) item. This it includes gene editing, breeding and genetic engineering. These techniques are all different but the modify an existing gene copy.

Modified so that it better meets our needs, such as disease resistant etc.

Something that has been modified beyond what the plant/animal could be breed to in its natural environment

Any food that has genes introduced by man's involvement

Becoming increasingly difficult, especially cisgenic modification through shifting of genes within a species using genetic tools

Food that has been genetically modified by man rather than evolving naturally

Any product where the genetic code has been directly altered by man

Genes edited to alter genetic composition of an organism

Traits selected for by methods other than open pollination or breeding. Chemically induced methods of accelerating mutation of traits

Food which is or part of has been developed in a lab

GM is where science modifies the genes of plants/animals to improve growth, disease resistance, insect resistance, increase production with decreased inputs

Modified for improvement

Its DNA is altered by selective breeding or intervention for a specific purpose

Modified within a lab

Where the genetics have been altered to provide some benefit.. i.e. disease resistance, healthier crop or better yield

I have no issue with GM foods. Genes added into the food to improve traits of that food.

Q 9 - Milk alternatives total sales are growing globally. In your own words, why do you think is this happening mainly?

Change in health fads and generations. actual awareness of where food products come from and how they are produced being vague.

Allergies.

I think the biggest drivers are a perception (rightly or wrongly) of being a healthier alternative - and that they are new and 'trendy'. Possibly cheaper also? Possibly longer shelf life?

More people are becoming aware of the environmental impact of intensive dairying operations and choosing to change their lifestyle to help address this. Also, more people are being diagnosed lactose intolerant. better diagnostics & easier readily available alternatives have helped both these Pont.

Increased number of allergies from dairy and an increasing need for cleaner, sustainable nutrition

Lactose intolerant, a longer shelf life.

Perception, diet changes and a growing population

Seen as healthier, food trends with paleo etc., for some lactose or food intolerances/allergies are driving this

People "want to do good". They try to get the same benefits of real milk without affecting the environment and or animals.

Different diet styles coming through and a rise in paelo, vegan lifestyles due to the belief that they provide a healthier diet and wellbeing

Probably mostly driven by allergies. Also, possibly and anti-animal use crowd

More global awareness, allergies, perception that they are healthier, maybe some are still having cow’s milk as well?? taste for some,

Openness to new alternatives, products with a better story, less environmental impact, people becoming disenchanted with naturally produced products due to fear campaigns from activist groups, alternatives for people with food allergies or intolerance.

For animal health and welfare reasons, people are moving away from animal produced milk as it is 'the right thing to do'

Environmental awareness of effects of dairy, belief alternatives provide health benefits

People think of them as a healthy alternative to cow’s milk, and or they are doing it on animal welfare grounds, or they think it is more sustainable (environmentally friendly).

People think they are healthier

Cost or environmental concerns

I think there are two reasons. Once is health based and another is taste. Some people don't like the taste of cow’s milk and have found they like rice milk or almond milk for example. Other people may be allergic to cow’s milk but can drink an alternative milk.

Vegan/vegetarians/animal welfare

People have the ability to research further in to what they are eating. This does not necessarily mean they are therefore eating what is best for them nutritionally however as sometimes its means they have stopped researching when the information found resonates with what they want to believe

Fashion and misunderstanding

Concerns re nutrition, animal welfare and allergies (most will be perception and may not be 'real')

People's perception of healthy food

The sales of most food products are growing globally including milk and milk alternatives. milk alternatives, like gluten alternatives are becoming fashionable in affluent markets.

More Alternatives are available than in the past

The correctly perceived, poor farming practices throughout the world, leading to poor animal conditions that people can no longer turn a blind eye to. Farming has become a highly commoditized where production and profit out way environmental and animal welfare issues where mass scale is concerned.

Dairy/ lactose intolerance. Also trend and mis guided information leaving people thinking that it is better for them and planet.

People are becoming more aware of the impact on the environment that animal production has and want your decrease their environmental footprint. Belief that animal products especially dairy is damaging to health belief that plant based milks are better for health.

Health shift world wide

Due to intolerances.. not necessarily lactose, but A1 protein intolerance which is often mistaken for lactose intolerance. A1 cows have become predominant as a consequence of prolonged single trait selection in the dairy industry. People can tolerate A2 milk better.., most don't know this or don't have access to A2 milk

More people having camp intolerance and they are a good alternative

More intolerance, prescriptive health choices, an increase in vegan diets also milk alternatives can be produced in countries where fresh milk is not available, and a suitable alternative to powdered milk.

Trends for alternatives, allergies, green or Eco foods, veganism, marketing.

Q 10 - If in the next 10 - 20 years milk alternatives can match the price, nutritional value and taste/texture of cow’s milk, do you think the next generation could switch over to this product? Why do you think this?

Yes. But I believe such a transition will be very slow, given the complexity of mammalian milk. If one looks at mankind’s attempts to duplicate human breast milk in the form of infant formula then a precedent is clearly set. Compared to the complexity and sophistication of human breast milk, our attempts to create alternatives (even basing

these on an equally complex biological material, bovine milk) are crude in comparison. Nutritionists, pediatricians, scientists, and mothers universally recognize this and use infant formula only as a fall back option when breast feeding is not viable.

Never entirely, will always be in demand in some capacity. may be as a luxury, natural product

I think there is an increasing demand for cleaner sustainable foods and consumption for these alternatives will increase, I believe there will still be demand for natural dairy protein though

Yes, it would be price related. Environmental factors. E.g. using less water to create the milk

With the increase in population I think there may be a need for some food to be produced this way. If the price point was below that of cow's milk and if it could prove it is environmentally a better product then it may get some traction with the more premium product being the real deal from animals.

Yes, because there is no perceived difference - if fact there may be environmental benefits etc.

Yes, because it appeals to mainstream citizens that don't think/care about how these synthetic food (lab milk or meat) are produced. Personally, I believe the negative effects (side effects as cancer, tainting, etc.) will be seen after 20 years of consumption of these synthetic products.

Possibly, it isn't the same is meat because the animal doesn't die. However, there is a huge push towards environmentally friendly and ethically produced food. This would push away from cow's milk onto an alternative product that was created with less impact than cow's milk.

Yes, is price being cheaper. But I believe there will always be a market for natural product if it meets high animal welfare/environmental standards

Maybe? i still think it would be personal preferences and tastes and belief

Yes, I do believe there would be consumers that would switch. These products might match on everything else but tell a different story with a brand that matches the values of different consumers. That is why our industry needs to connect more closely with the consumer to maintain relevance.

Yes. Same answer as Q9 :-)

Probably, but it is difficult to see how milk alternatives could taste or react the exactly same, so I think there will always be a market for cow's milk

Yes, I do think if milk alternatives have no barriers/differences to natural milk a portion of the population would switch over, but I also think you will get more awareness around "real" milk which could push it up in value relative to milk alternatives. It is all about perception.

Some will due to personal view about animal welfare and environmental concerns, others will prefer the natural product

If it's healthier, cheaper, more environmentally friendly I.e. reduction in cow numbers crapping in waterways and has market appeal it will most definitely have a strong appeal in then market with the next generation

From my reading, I think this could occur in the bigger cities - especially in the West. There seems to be growing concern about how animals are treated. This people may change for animal welfare reasons. There are also some parts of the world where people cannot easily digest milk - parts of Asia for example. If the price of milk alternatives can be reduced sufficiently then plant-based milks may be preferred.

Unsure if they will. Cow’s milk has the perceived value of being natural as an advantage.

Yes, because even today our youth are losing touch with what real milk tastes like and the understanding of where milk even comes from so it would not be hard to change the product and them be none the wiser as to the different manufacturing methods

Yes. If it is price competitive, and has lower environmental impact

Yes. Likely still to be a place for 'natural' product, but may be at lower volume.

Possibly but think natural cow’s milk will always have a market, possibly niche

Yes - price wins.

In theory they could, but will they?

Many will if the farming practices we currently use are not realigned to the perception of consumers. This may in turn raise the price of milk and milk products, further making milk alternatives a viable option. Awareness and focus on how the alternatives are grown (almond - very high water user in water short areas, Soy - 90% GMO, Rice - high water user/polluter) should be communicated to show how milk is a responsible choice if the farming is better than what is currently considered as sustainable.

Yes, as it will become easy to acquire also there could be a belief that it is more environmentally friendly

If it is seen to have better health and environmental outcomes I believe a lot of people would see it as a no brainer.

Highly possible. Why wouldn't they

I think they will as their values and ideologies are quite different. I think, like it or not, the social pressures put on food from animals will influence this. Hope not.. but I think it will go this way unfortunately

Yes, cow’s milk is made for cows. Most alternatives are the same if not better.

I really think so as there is growing pressure on the environmental impact of milking cows

Yes, it will more than likely be more sustainable for the environment and just as good for you.

Yes, but the this will depend on the how the alternative is developed. I do not think price and taste/texture are the only factors.

No, we still need natural products with anti-bodies for humans. Also, diary stock also produce meat products.