MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Bioeconomy Research: Key Findings

Purpose

This note summarises the key research findings from six reports on emerging and future low-emission and high-value opportunities in New Zealand's bioeconomy. The research informs the development of the Government's Circular Economy and Bioeconomy Strategy.

Introduction

Developing a Circular Economy and Bioeconomy (CEBE) Strategy is an action in the Government's Emissions Reduction Plan (ERP). MBIE is tasked with leading this work.

The Emissions Reduction Plan sets out actions the Government intends to take to put Aotearoa New Zealand on a path to achieve our long-term climate targets and contribute to global efforts to limit temperature rise to 1.5˚C above pre-industrial levels.

For the purposes of this research, "bioeconomy" is defined as the sustainable production and conversion of biomass, for a range of food, health, fibre and industrial products and energy, where renewable biomass encompasses any biological material to be used as raw material.

As well as emissions reduction, a shift to more circularity in the economy, with a sustainable bioeconomy, can contribute to other environmental, economic, and social outcomes including new business opportunities.

MBIE commissioned Coriolis Research to identify the emerging or future areas of the bioeconomy that could support the shift to lower emissions and a high value economy.[1] Opportunities are focused on high value use of bioresources, utilisation of current bio waste streams, potential for increased circularity, or reduction in emissions and dependency on fossil fuels.

The research fills key knowledge gaps, identifying several high value bioeconomy opportunities that are already gaining traction in New Zealand but to date have flown under the radar. The six reports will be placed on MBIE's website. It is expected that making this detailed information available publicly will reduce friction in the market by stimulating interest and investment in bioeconomy opportunities.

The bioeconomy is important to New Zealand…

The New Zealand economy is significantly driven by the production and processing of bioresources.

- The bioeconomy accounts for 60% of land use and at least a quarter of employment in New Zealand, depending on whether you include tertiary sectors and service providers. It is the basis of New Zealand's regional economies. In addition, food and beverage manufacturing is around a third of all manufacturing in the Auckland region.

[1] https://www.coriolisresearch.com/

Table 1: McKinsey Three Horizons Framework

The three horizons framework is a tool for managing business growth using three horizons that represent 1. short-term building and maintaining current core business; 2. medium-term expansion and exploration into new opportunities; and 3. research and ideas for future growth and new business opportunities. The chart below uses New Zealand's processed foods industry to illustrate the framework.

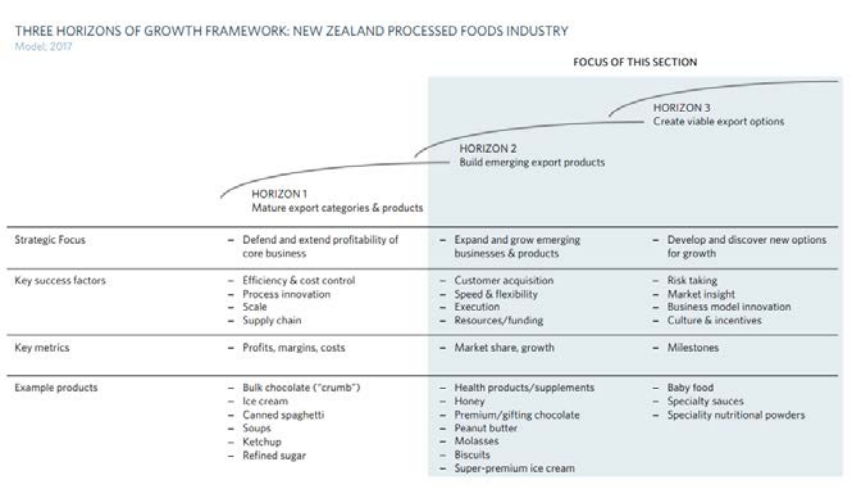


Chart source: https://www.mbie.govt.nz/assets/b4d32e88be/investors-guide-to-the-new-zealand-processed-food-industry-2017.pdf

- Total goods exported in 2021 were $63.3 billion, of which 75% ($47.5b) were derived from biological resources. The bulk of these exports can be defined as "McKinsey Horizon One" (see Table 1 below). These are New Zealand's core biological industries that provide the greatest profits and cash flow. Major platforms include, dairy, meat, wine, horticulture, seafood, processed foods (including honey), forestry and wood processing.

…but generates the major share of greenhouse gas emissions.

Currently New Zealand's economic activity exceeds environmental limits on several measures, of which greenhouse gas (GHG) emissions is one. As a signatory to the Paris Agreement, New Zealand's Nationally Determined Contributions (NDC) target is to reduce New Zealand's net emissions by 50 per cent below gross 2005 levels by 2030. An important complication is that the wider bioeconomy (including upstream and downstream industries) is New Zealand's largest single contributor to climate change, generating circa 57% of emissions.[2]

To achieve New Zealand's NDC targets will require New Zealand's bioeconomy to shift from being 'part of the problem' to being 'part of the solution'.

[2] Source: Ministry for the Environment (https://environment.govt.nz/publications/new-zealands-greenhouse-gas-inventory-1990-2020/); Coriolis classification (where possible) and analysis

Research Scope and Approach

To identify how this shift might occur MBIE commissioned research to:

- Identify tangible emerging bioeconomy platforms (ie McKinsey Horizon 2) that are attractive investments.
- Identify potential future platform options (ie McKinsey Horizon 3).
- Provide commentary on the key trends and drivers for each of these platforms.
- Provide an assessment of barriers and challenges including policy, regulatory and market settings, and commentary on options to address these.
- Rank the platforms, enabling priority platforms to be identified and further assessed.
- Provide an in-depth analysis on three high priority platforms.

The research focused on 'platforms'…

The research focused on higher level "platforms" (eg marine bio-actives) rather than specific products within those platforms (eg mussel powder), albeit the boundary between the two is sometimes blurred.

.. and on high value low emissions opportunities

The research focused on platforms that use bioresources (including waste streams) to their highest possible economic, social and environmental value and have potential to utilise more circular systems in their production, processing and consumption. Because of the future focus, existing incumbent industries at scale (eg dairy) were out of scope, but value-added products derived from these industries (eg high value nutritional products with dairy ingredients) were in-scope.

The research focusses on opportunities that leverage New Zealand's existing capabilities …

The research assessed New Zealand's available bio-resources and existing primary sector capabilities ("what do we have to work with?") and New Zealand's wider pan-sector capabilities ("what are we good at?").

…and from the point of view of investment readiness.

New Zealand is an open market economy. The development of the future (or "new") bioeconomy will require significant private sector investment, potentially with co-investment by the public sector or other forms of public sector support. For this reason, the research evaluates opportunities from a commercial investor perspective to identify high potential platforms that:

- Are clear business opportunities (Is it an attractive market? Is it investment ready? Can it be produced or processed in New Zealand competitively?); and
- Support the development of the bioeconomy of the future (Does it move us towards our environmental goals through creating more value from existing resources, reducing agricultural GHG emissions, replacing fossil fuels and/or rethinking waste?).

Both production and processing systems were assessed

The New Zealand bioeconomy is comprised of two different activities:

1. Biomass production systems (eg farming, forestry) that produce raw materials (milk, fibre).
2. Biomass processing systems (eg milling, meat processing, brewing, packaged consumer foods manufacturing, wood processing).

These two systems have very different characteristics and so were evaluated separately.

Six Research Reports were delivered.

Six reports were delivered, comprising around 1000 pages of analysis and commentary.

- Report 1 sets out the overall framing of the research, the screening methodology and evaluates 100 platforms.
- Report 2 develops thirty high potential opportunities emerging from the stage one evaluation.
- Reports 3, 4 and 5 provide detailed analysis of three high potential opportunities: Sports Nutrition; Biocosmetics; and Marine Bioactives.
- Report 6 provides a detailed assessment of New Zealand's available bioresourses and "in-sector" capabilities (see Figure 4 on page 7 below), our wider "pan-sector" capabilities such as number of researchers, and relevant degrees. It also provides analysis on the drivers of bioeconomy competitiveness and barriers to developing new bioeconomy platforms in New Zealand.

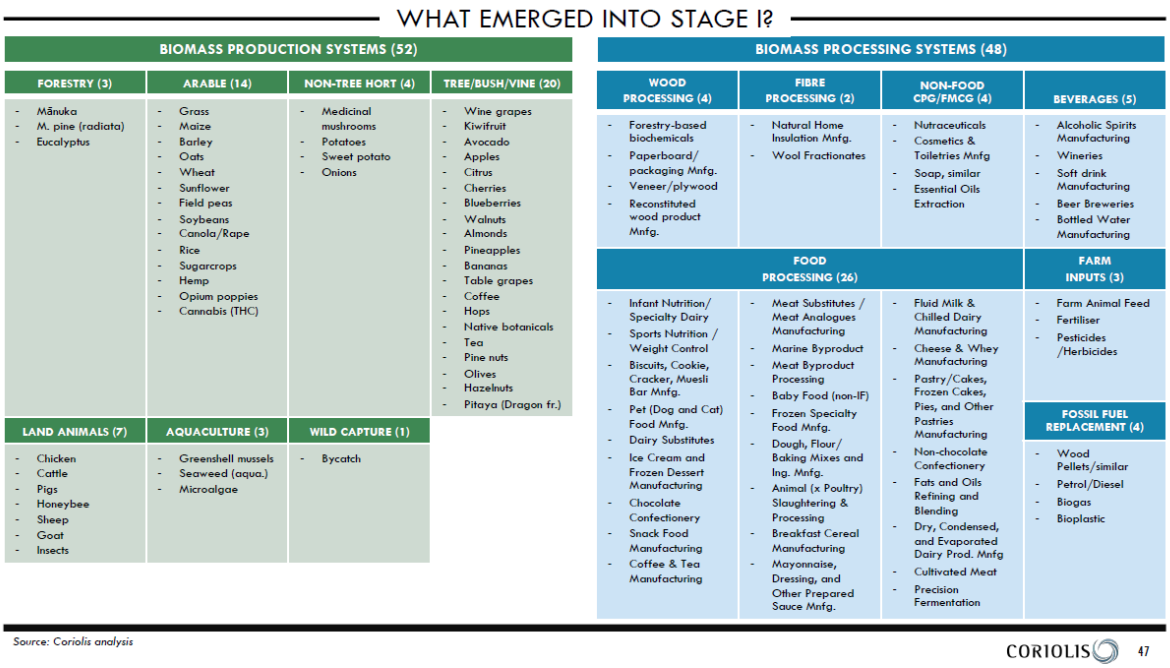
These will be made available on MBIE's website and publicised through MBIE and NZTE channels and industry networks.

Findings

One hundred platforms were evaluated…

An initial screen ("Stage 0") of all biomass production and processing systems being pursued by "someone, somewhere" in New Zealand yielded 52 production systems and 48 processing systems for evaluation in Stage 1 (100 in total). (See Figure 1). These were evaluated against a set of common metrics to identify high potential platforms that are both clear business opportunities and support the development of the bioeconomy of the future.

Figure 1: One hundred biomass production (52) and processing (48) systems emerged into Stage I for evaluation.



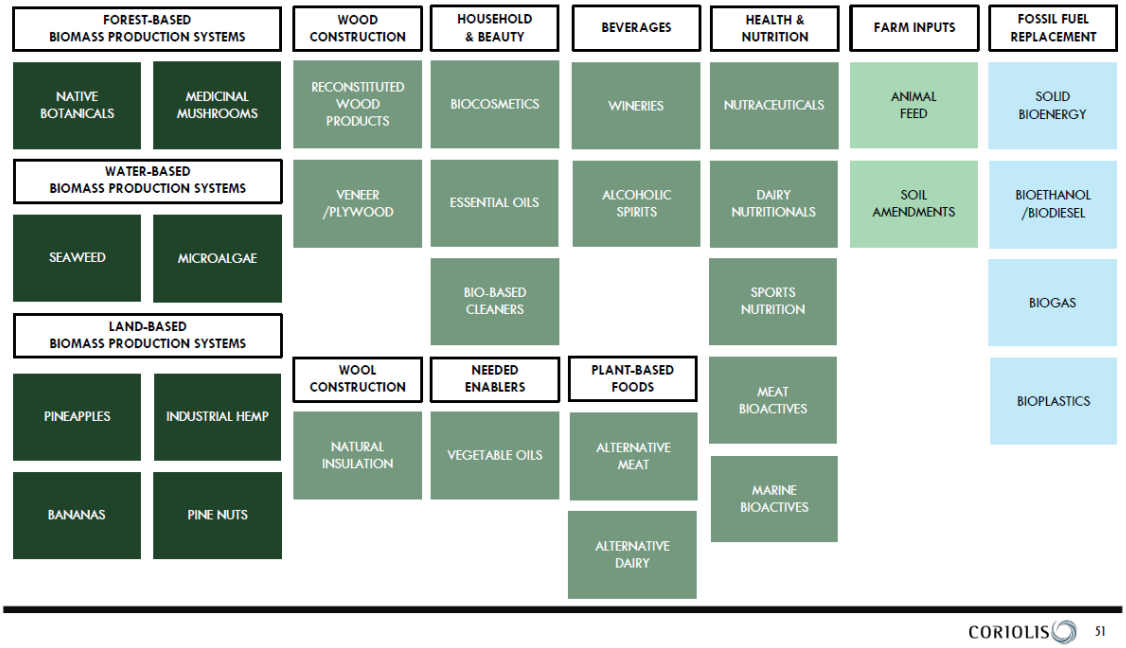
…delivering thirty high potential opportunities.

The thirty platforms that emerged from Stage 1 into Stage 2 are spread across a wide range of systems, products, processes, and categories (see Figure 2). Note that eight of the thirty are potential new sources of biomass (e.g., hemp, bananas, seaweed) while the remaining 22 all entail some form of processing.

There was no perfect platform. Different identified platforms addressed different requirements of the bioeconomy of the future. Nevertheless, all present solid opportunities. Some platforms such as microalgae and seaweed are currently either small or at a more experimental stage and require several factors to go in our favour such as the adoption or invention of mechanised farming systems. Others, such as dairy nutritionals and nutraceuticals, are well established with significant potential to grow.

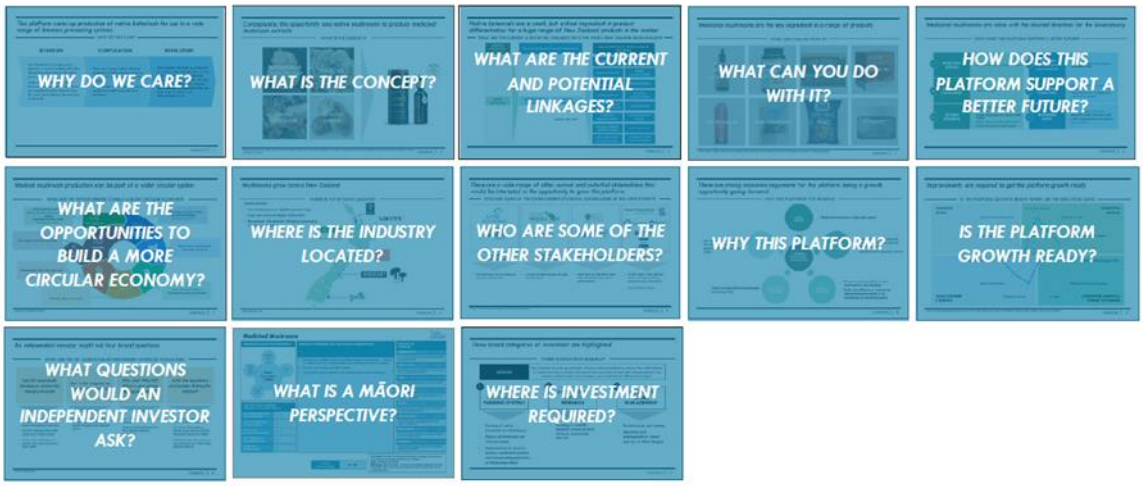
The selection of the thirty platforms was informed by interviews with selected stakeholders from industry, science, and government.

Figure 2: 30 high potential bioeconomy platforms



Stage 2 develops each platform individually from a whole of value-chain perspective by answering a set of common questions resulting in a 14-page analysis for each platform (See Figure 3). This includes an analysis from a Māori investor perspective. Opportunities to implement more circular practices (eg in packaging, use of waste streams) are also identified. To date we have had little visibility of or knowledge about many of these opportunities, especially in categories such as “household and beauty” and “health and nutrition”.

Figure 3: Questions for development of the thirty opportunities



Stage 2 opportunities includes consideration of fossil fuel replacements

Five "fossil fuel replacement" platforms–solid bioenergy, bioethanol/biodiesel, biogas, bioplastics and forestry bioechmicals–are all given a Stage 2 analysis. Key findings are:

- Proven technology to produce liquid biofuels exists, but the economics do not currently stack up in the absence of significant and likely ongoing government support. Attempts at liquid biofuel production to date in New Zealand (and Australia) have not succeeded and lost money or are very small scale and supply constrained (eg if using feedstock from tallow, whey, or recycled vegetable oils).

- With respect to utilising New Zealand's substantial plantation forestry resources to replace fossil fuel products, current market indications are that investors are likely to prefer production of higher value products such as biochemicals and bioplastics.[3]

- Solid biofuel suppliers (eg pellets) are well established in New Zealand (eg Azwood) and conversion of coal boilers to wood pellets and similar solid wood fuels is occurring.

- Similarly, biogas production from food waste, landfills and other sources is commercially viable with production facilities around the country.

Significant other government funded research on these platforms is available and there are work programmes underway in several agencies. Examples are the Forestry and Wood Processing Industry Transformation Plan, the Wood Fibre Futures Project, various research and investments by EECA and MBIE projects to develop sustainable aviation fuel and support biogas developments.

[3] See for instance https://www.nzbioforestry.co.nz

Three high potential opportunites were given an individual "in-depth" treatment.

Based on the Stage 2 analysis, three high potential platforms were passed through to Stage 3 for detailed analysis: biocosmetics; sports nutrition; and marine bioactives. These platforms have the following charateristics in common:

- Create very high value knowledge-intensive products from New Zealand's biomaterials (including waste streams).
- Products are typically light weight as well as high value (a standout is mussel oil at $2000 a kg).
- In most cases these products combine multiple ingredients, with complex value chain links.
- Multiple New Zealand firms are already demonstrating success.
- While generally under the radar, are already valued at around $100m plus export categories with significant upside.[4]
- Score positively as attractive to Māori investors, particularly marine bioactives.
- Play to New Zealand's branding strengths in the growing "health and wellness" and "natural products" categories.

In addition to the objective of developing new bioeconomy industries, the three platforms also play to other recent policy themes such as "volume to value", "diversification" (e.g. into high value, light weight knowledge-based products), and a focus on development of the Māori economy.

The Stage 3 reports provide a rich set of information, covering topics such as strategy and investment, key markets, key competitors, circular frameworks, growth opportunities, firm activites (eg investment in new plant, mergers and acquisitions) and profiles of key New Zealand firms.

New Zealand imports significant "fresh" biomass…

The research finds that New Zealand imports large quantities of "fossil" biomass (eg refined petroleum products, coal, plastics etc.). New Zealand also imports significant quantities of processed and unprocessed "fresh" biomass, the majority of which is fed to animals. This includes:

- 2.5 million tonnes of processed animal feed (around 2 million tonnes of which is palm kernel expeller (PKE))
- 764,600 tonnes of cereals (much of which is animal feed)
- 392,000 tonnes of sugar
- 167,000 tonnes of vegetable oils

[4] These complex products are often categorised in several trade HS (Harmonized System) codes so exports may be under-reported. For instance, Statistics NZ report $104m in cosmetics exports, but the industry estimates the export figure at closer to $400m with potential to at least double. In addition, these products often have significant sales through Daigou (e-commerce) channels.

- 165,000 tonnes of fruit.

The research finds that the importation, growing, processing, storing and distribution of animal feed is likely to be one of the largest industries in New Zealand, driven by the growth and intensification of the dairy industry, although the growth of poultry production is also a driver.

…and the ability to substitute this with local production is currently limited.

The research finds that New Zealand could replace some biomass imports with production in New Zealand, eg vegetable oils and additional animal feed.

Very little of New Zealand's arable and pastureland is currently used to produce grains, oilseeds, or non-grass fodder crops. Pinus radiata, cattle (including dairy cattle) and sheep are around 57% of land use, while arable farming is just 1.4% and orchards/vineyards are 0.4%. The area in human-focused arable crops has been declining, while the area in animal-focused arable crops has been increasing. Eighty-two percent of arable crops grown in New Zealand are fed to animals (eg maize); only 18% goes into human-focused chains.

New Zealand's arable crop industry has high yields and years of experience. The key issue is that, under current settings, it struggles to compete for land use with the returns of dairy per hectare and the expansion of lifestyle blocks. For this reason, we have seen the expansion of dairy in regions like Canterbury and Southland that previously had substantial arable cropping industries.

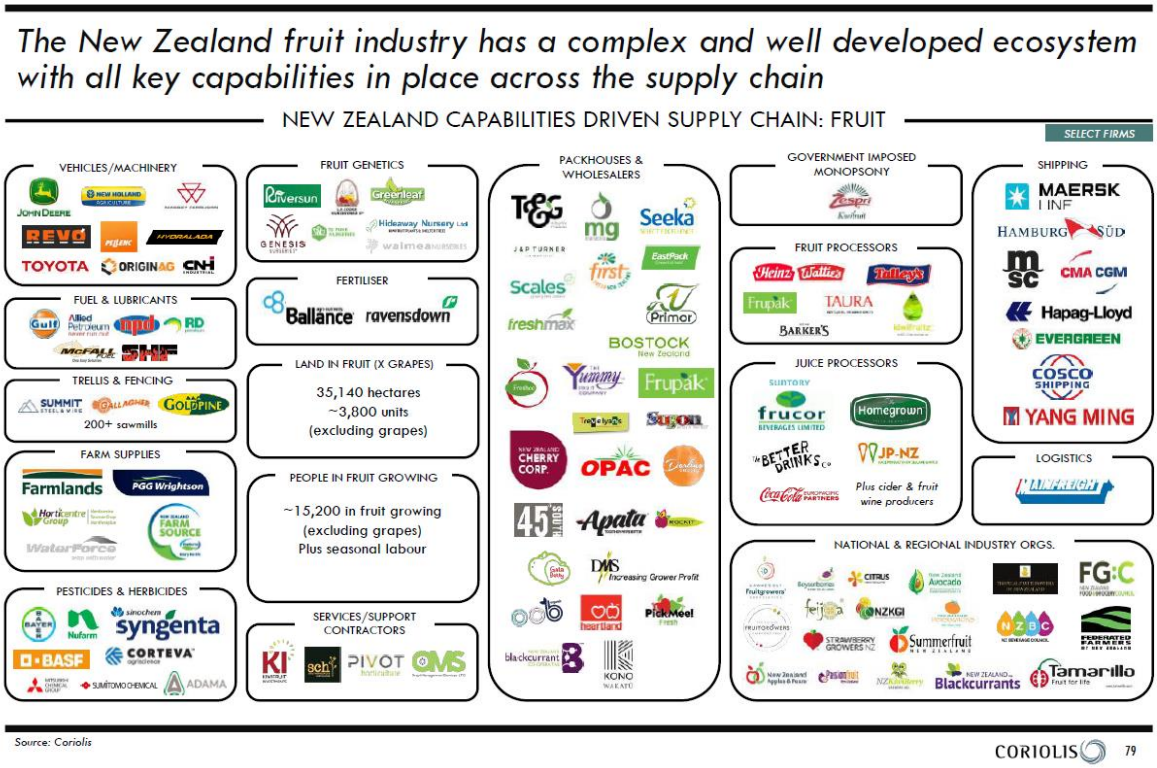
Our core bioeconomy production systems are highly competitive…

Currently New Zealand has a small number of at scale highly competitive bioeconomy production systems which produce products the world wants at a price the world will pay. These include red meat, dairy products, kiwifruit, wine, apples, unprocessed logs and most seafood.

The competitiveness of these systems emerges from the degree to which a complex set of capabilities are in place across the whole value chain, which can be conceptualised as a well-developed ecosystem.[5] (See Figure 4). Note that the science system is only one of many required capabilities.

[5] Exports of unprocessed logs, for instance, while a commodity export, still requires logistics, specialised port infrastructure and bulk carriers, and intermediaries such as log traders and exporters.

Figure 4: Capabilities across the value chain



Critically, the development of the necessary ecosystem takes time. More recent production systems such as kiwifruit, avocadoes and wine achieved traction only after a long period of gestation and hard work, typically twenty to thirty years.

…while some "bio-secure" production systems lag behind global best practice.

Several of New Zealand's bio production systems are protected from international competition for biosecurity reasons, eg kumara, chicken meat. Lack of competition from imports has resulted in New Zealand operators in these industries often being less productive than global leaders.[6]

New bioeconomy production systems must rapidly become competitive…

The extent to which New Zealand can develop new bioeconomy production systems at some scale – such as canola, eucalyptus, industrial hemp, bananas – will be determined by whether these systems can rapidly become internationally competitive. Similarly, the expansion of established systems (such as wheat or oats) is dependent on returns being competitive with other existing land-uses, dairy being the prime example as indicated above.

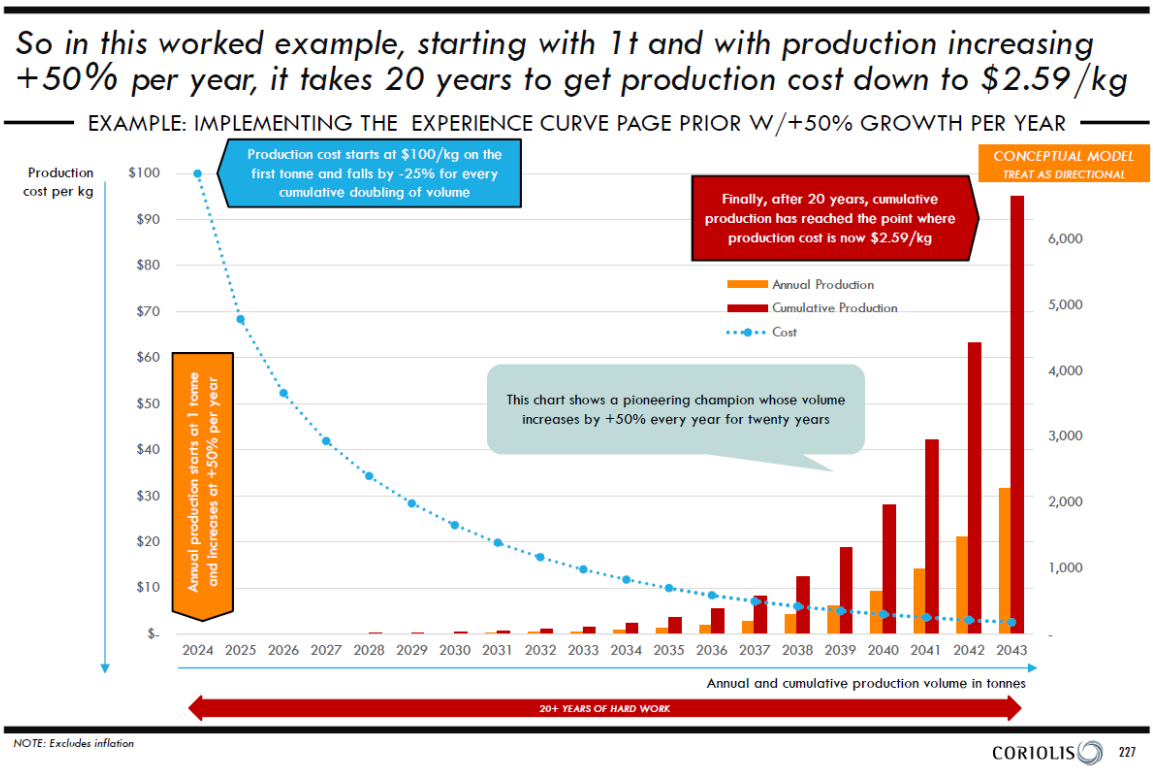
[6] South Carolina sweet potato (kumara) growers achieve twice as many tonnes per hectare as New Zealand growers. Being un-competitive, New Zealand does not export kumara.

In New Zealand's open market economy, demand, eg China's demand for animal protein, is a major driver of shifts in New Zealand land-use (dairy conversions). Similarly, the challenging economics of increasing onshore processing of logs is in part driven by the fact that demand from China for unprocessed logs sets the price, and that global trade in logs more generally is significantly distorted.[7]

…creating a chicken and egg challenge...

For new production systems to successfully become established operators, the industry must rapidly go down the experience curve to get to a price competitive with imports.[8] This is a key "chicken and egg" challenge for diversifying New Zealand's bioeconomy, eg the introduction of new crops.[9] "We have high costs because we haven't gone down the experience curve" but "we cannot get any experience because our prices are too high".

Figure 5: Experience Curve and Cumulative Production Costs



[7] For example, through other countries subsidies and/or export taxes. See Ballingall, John and John Stephenson. Impact of global trade distortions: effects on NZ exports of logs, timber, and fibreboard. Final report to MFAT November 2019.

[8] The experience curve proposes a constant relationship between the cumulative production quantity and the cost of production. That is, as the volume of production increases, the cost per unit of production decreases.

[9] This applies more broadly, eg to bioenergy, bioplastics or any good that requires scale.

…that likely requires government action to resolve.

The research finds that up until the 1980s the government was an active participant in the development of new bioeconomy industries in New Zealand. Most of the systems we have today were established in that environment.

In the last 30-40 years New Zealand has produced many ideas, eg through the science system, but success in executing these ideas (commercialisation, scaling) has been limited. With production systems, New Zealand appears to be stuck in McKinsey's unhealthy pattern called "ideas but not building businesses."[10]

A key reason for this would appear to be a lack of public sector investment since the 1980s to adequately fund the necessary supporting physical, knowledge and financial infrastructures and institutions, eg focused innovation policies, pilot facilities and biorefineries, market information and analysis, relevant business and technical skills and patient capital.[11] That is, those capabilities in supporting ecosystems which are necessary for competitiveness and that often require some form of government intervention for their development and funding.

But New Zealand has significant opportunities to add value to existing bio-resources.

The research finds that secondary and tertiary post-farmgate processing (manufacturing) is highly flexible, adaptable, adjustable, and not directly tied to the land. That is, it is easier to win through processing our existing bioresources into their highest value applications than by developing new bioresource production systems. The three platforms selected for individual in-depth reports–biocosmetics, sports nutrition, and marine bio-actives–exemplify this. Others identified in the research include meat bio-actives, bio-based cleaners and plant-based meat alternatives.

These processing systems identified as emerging investable opportunities are not "islands"; they overlap into a network or web of capabilities with a variety of inputs (Figure 6). They are adjacencies to our core industries building on and extending our existing strengths and capabilities. They drive growth in the wider knowledge-based ecosystem through increased demand for plant and equipment, innovative packaging (eg recyclable, multiple use to support circularity) and services such as research and development services, marketing, branding, design, and sales.

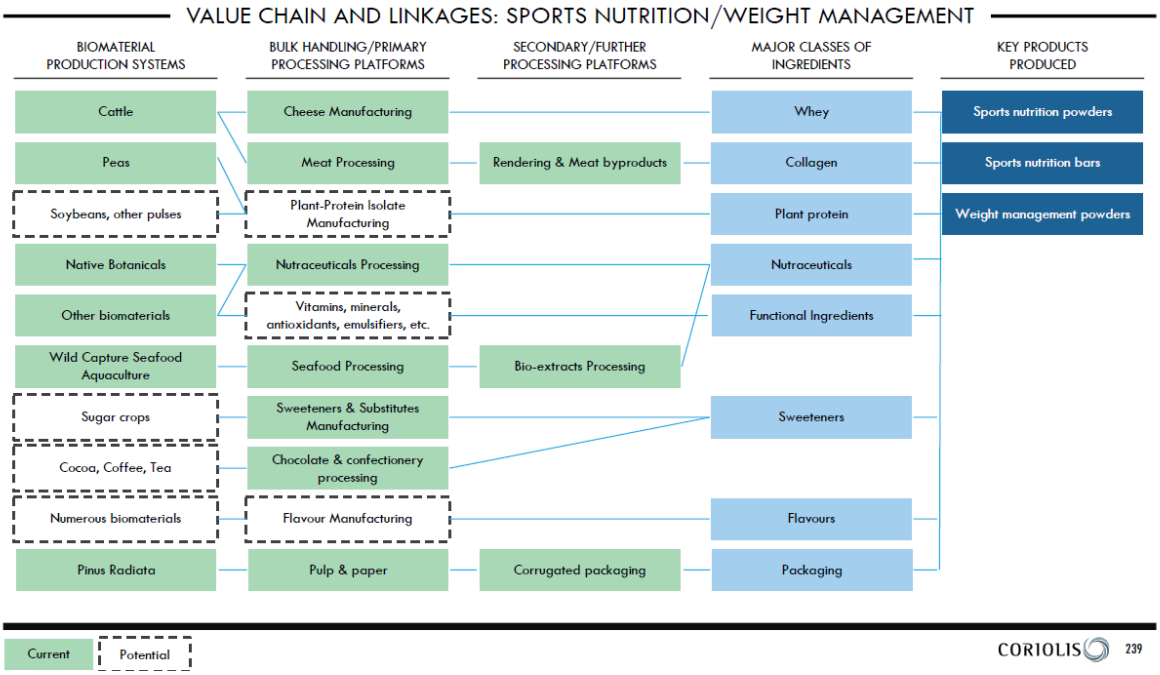
The growth of post-farmgate processing platforms also creates demand for a range of inputs some of which are currently imported, such as vegetable oils and pea protein. Growth in demand for these imported inputs could stimulate increased local production in New Zealand-where this makes sense-reversing the decline of New Zealand's arable cropping industry and providing alternatives to dairying.

[10] Baghai, Coley, and White. The Alchemy of Growth: Practical Insights for Building the Enduring Enterprise. 2000.
[11] As discussed in the Productivity Commission's Inquiry on Frontier Firms https://www.productivity.govt.nz/inquiries/frontier-firms/

Importantly, the more value that is created from existing resources the more it provides scope to achieve greater economic value while limiting or even reducing resource depletion and environmental impacts.

Figure 6

Sports nutrition is a more complex platform that brings together a wide range of New Zealand and imported ingredients into value-added products



Conclusion

Many things can be grown in New Zealand.

Developing new sustainable biomass production systems such as industrial hemp, seaweed or pineapples is a hard task. It requires investment in the development of supporting capabilities by both the public and private sector to enable rapid scaling to go down the experience curve and become competitive.

This is the over-riding issue in an open market economy. Can a new source of biomass be grown and processed in New Zealand commercially in competition with offshore producers? That is, at sufficient scale and at a price point acceptable to business customers or consumers? Can it deliver a return close to or superior to current land-uses-particularly dairy-under current settings?

The research concludes that “The New Zealand government will need to take a more proactive approach if it wants new biomass production systems (eg hemp, canola) at scale to emerge.”

Given these constraints, the most easily executed opportunities for New Zealand’s bioeconomy appear to be post farm gate through adding value to existing biomass, utilising

waste, and creating complex products, as the three in-depth reports on biocosmetics, sports nutrition and marine bioactives illustrate. (See Figure 7).

This research confirms previous research which showed that the New Zealand bioeconomy processing industry is clearly moving from simple to more complex value chains, and achieving growth through the development of knowledge-intensive products that align with consumer trends.[12] With the increasing numbers of start-ups, a cohort of established firms, export growth and local and foreign investment, the market has clearly identified value-added bioeconomy products as profitable opportunities.

Figure 7: Examples of Marine Bioactive Consumer Products

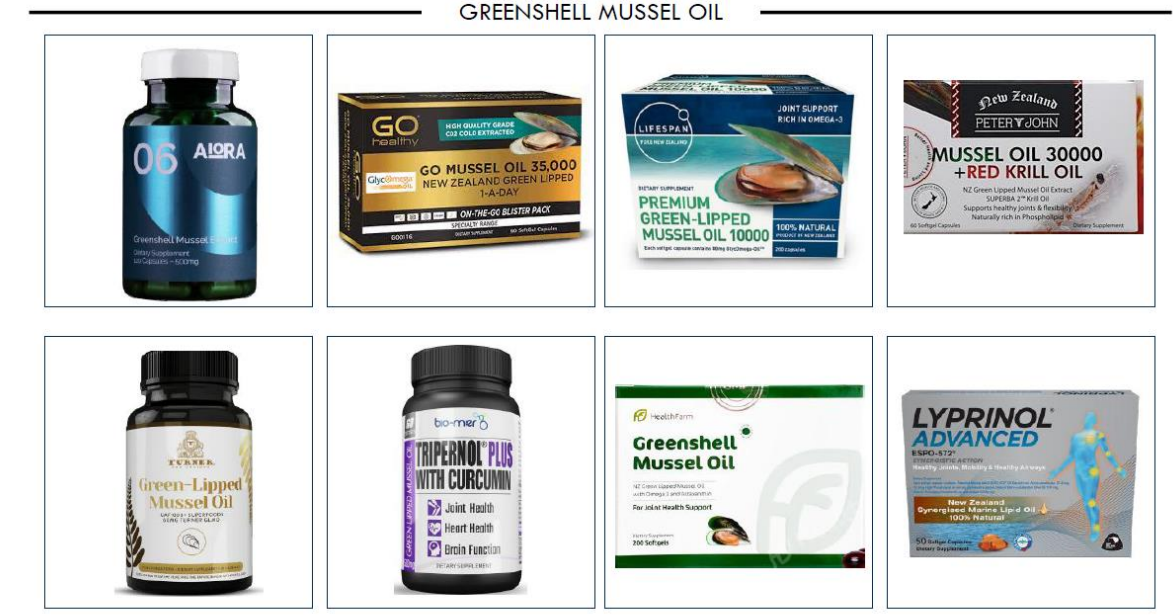


Image Credit: WikiMedia: CC ASA

[12] See the Food and Beverage Information Project reports, available at https://www.mbie.govt.nz/business-and-employment/economic-development/growing-the-food-and-beverage-sector/food-and-beverage-information-project/food-and-beverage-investor-guides/