



Emerging Proteins NZ Project: Interim
Analysis of Round One Delphi Interviews
Centre for Sustainability Discussion Paper No. 6.

April 2023

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Sinclair-Thompson, A. *The Lab of Milk and Honey: Discourses in Aotearoa New Zealand Media that Envisage a Synthetic Protein Future*. Centre for Sustainability Discussion Paper No. 6. (2022).

McLeod, C., Grice, J., Campbell, H. and Herlith, T. *Super Salmon: The Industrialisation of Fish Farming and the Drive Towards GM Technologies in Salmon Production*, CSAFE Discussion Paper No. 5 (2006).

Kaye-Blake, B., Campbell, H., Plummer, C., Kitto, L., Polson, C., McKay, W., Fitzgerald, R., and Saunders, C. *The GM Food market: A Current analysis*. CSAFE Discussion Paper No. 4. December (2003).

Plummer, C., Kitto L., Polson C., and McKay, W. *Co-existence of GM and Non-GM crops: A*

Review of International Evidence. CSAFE Discussion Paper No. 3. July (2003).

Manhire, J., Campbell, H. and Fairweather, J. *Pathways Towards Sustainability: Comparing Production Systems Across Four Sectors of New Zealand Agriculture*. CSAFE Discussion Paper No. 2. February (2003).

Campbell, H., Fitzgerald, R., Saunders, C. and Sivak, L. *Strategic Issues for GMOs in Primary Production: Key Economic Drivers and Emerging Issues*. CSAFE Discussion Paper No. 1. October (2000).

Research Reports

Kemnitz, N., Campbell, H. and Burton, R. (2022). *Technology Crises in Primary Production: The Transition from Wool to Artificial Fibres in New Zealand*. Centre for Sustainability Research Report No. 6. April 2022.

Cooper M, Campbell H, Manhire J, Moller H, Rosin C, Norton S & Hunt L (2009) *New Zealand Organic Sector Report*. CSAFE Research Report No. 5, October 2009 commissioned by Organics Aotearoa New Zealand Organics (OANZ).

Grice, J., Cooper, M., Manhire, J. and Campbell, H. (2007). *The State of the Organic Sector in New Zealand, 2007*. CSAFE Research Report No 4.

University of Otago: Dunedin.

Grice, J., McLeod, C. and Campbell, H. *Evaluating the Social and Cultural Implications of GM Technologies in New Zealand Primary Production: A Case Study of Salmon and Other Aquaculture Applications*. CSAFE Research Report No. 3. June 2007

Stuart, A. and Campbell, H. *Technology Conflicts in New Zealand Agriculture: Comparing Contemporary and Historical Crises between Publics, Government, Business, and Science*. CSAFE Research Report No. 2. December (2004).

Campbell, H. and Ritchie, M. *The Organic Food Market in New Zealand*. CSAFE Research Report No. 1. June (2002).

Acknowledgements

This report was made possible by funding from Our Land and Water through the National Science Challenges grant. See the following link for details:

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Introduction: Protein Futures

Protein Futures NZ is a research project involved in future imagining for food and agriculture in Aotearoa New Zealand, with a specific focus on the potential impacts and opportunities of emerging proteins. The project takes a holistic perspective with researchers from the fields of agricultural science, economics, food science, Mātauranga Māori, and social science, operating with the Agribusiness group, Lincoln University, Canterbury University, and the University of Otago, as well as international contacts, most notably the Protein 2.0 project based in Norway. The scope of the project encompasses media and academic literature reviews, stakeholder interviews, technical and theoretical scenario modelling, and the dissemination of results with interest in policymakers as well as public audiences.

The purpose of this document is to introduce key points raised in stakeholder interviews. To do this, the document is theoretically premised on the work of Helliwell and Burton (2021), specifically with regards to the focus on promissory narratives for land-use change in response to emerging proteins. Following from this introductory report, focus will also be given to the regions of silence identified in interviews concerning the worlds new land-use may create, and the worlds it may destroy.

The term emerging proteins encompasses a wide variety of foodstuff that industry actors have been investigating with the hope of providing protein alternatives to conventional meat and dairy products. For the purposes of this document emerging proteins can be broken into three distinct categories that have garnered the most local media attention, and are expected to be the most relevant to Aotearoa New Zealand agrifood.

Protein sources:

Plant-based protein, which encompasses products constituted by plant extracts (e.g. pea protein in plant burgers, tofu, etc.), or those that involve whole plants or plant products (e.g. substituting tuna for jackfruit), although not taxonomically accurate, fungi and fungal products are also included within the plant-based umbrella. Plant-based products have become a mainstay of Aotearoa New Zealand supermarkets, including those processed by local industry, however, a local ingredients sector is significantly lacking (EPNZ 2021).

Precision fermentation involves the fermentation of microbes that may have been extracted from an animal product or genetically modified to express desired animal product qualities, through the use of yeast and sugars, to produce the likes of milk and egg whites in much the same way that beer is brewed. Precision fermented products have become commercially available in some retailers in the United States, however, at the time of writing market access remains limited.

Cell-cultured protein refers to products created by taking a cellular extract from an animal source, these cells are then fed on a serum and replicated over a scaffold in a bioreactor. Cell-cultured protein is genetically identical to source material. A limited range of cell-cultured products are available from the Eat Just restaurant in Singapore, and the technology has received approval in the USA. However, complications around scaffolding the structure and texture of a cut of meat grown in-animal, as well as questions of upscaling have to date restrained the commercial viability of the product.

International Trends and Aotearoa New Zealand

Recent reports show that emerging proteins only represent 2 % of the global market in meat by weight (Morach et al. 2021). However, funding for emergent proteins has increased exponentially in recent years (GFI 2022). Conventional meat consumption is expected to increase by 14 % in the next decade; however, the prediction is largely attributed to the expected growth in the middle class of the Global South, meanwhile meat consumption in many states of the Global North appears to have plateaued (OECD and FAO 2021). Consumer surveys show genuine public interest in alternatives to conventional meat and dairy, coupled with smarter marketing strategies means that while emerging proteins may only represent a small share of the current market, the industry is confident in its ability to target the weaknesses of conventional agriculture (EPNZ 2021).

Depending upon the ability of the local sector to adapt to international trends, emerging proteins may represent a threat to Aotearoa New Zealand's extensively pastoral livestock focused agrifood sector, should our consumer undergo a radical shift in their values and purchasing habits.

Although Aotearoa New Zealand has none of the industrial feedlot systems that emerging proteins are explicitly targeting; a shift away from conventional meat and dairy is likely to have downstream impacts on pastoral agriculture (Helliwell and Burton 2021). Furthermore, pastoral agriculture in Aotearoa New Zealand has its own environmental issues which represent push factors for the same reasons as more industrialised methods (MFE and Stats NZ 2021). On top of which, historical analogues in synthetic substitutions, such as in the vanilla and madder dye industries, suggest that it would be unwise to dismiss the disruptive potential of emerging proteins (Burton 2019).

On the other hand, emerging proteins can represent an opportunity for Aotearoa New Zealand agrifood, that could help in efforts to alleviate environmental degradation through diversifying landscape use, as well as benefiting a niche biotech sector (EPNZ 2021). That being said, currently national investments in emerging proteins significantly lags behind overseas agrifood competitors (EPNZ 2022).

Protein Futures NZ is interested in these potential opportunities. Additionally, the project realises that to understand the growth potentials of emerging proteins will require more than a technical understanding of the market opportunities and the barriers to upscaling, but also a social understanding of the thematic discourses being had around emerging proteins. Through a thematic analysis this document hopes to provide a collage of the voices surrounding emerging proteins, so as to envisage possible futures and address the complexities of their absences.

Methods

Researchers from the Agribusiness Group at Lincoln University conducted 22 interviews over the summer of 2022-2023. Interviewees were drafted through a meta-list of those known to be working in the emerging protein space, this consisted of attendants from the Emerging Proteins New Zealand conference, as well as various agrifood industry, governmental, and research organisations. The initial list consisted of 177 names, however, so as to avoid doubling up on interviews 13 were removed for having already taken part in MPI's protein roadmap, for which this project shares some thematic overlap. The remaining 164 potential

interviewees were sent a brief survey to gauge their role, level of understanding, and particular interests. Out of those who had responded and were willing and available to participate in interviews the final 22 were selected with the intention of providing representatives from each of the key drivers identified in Table 1, with the exception of Māori Development Opportunities, which will be addressed in separate reporting.

Table 1: Drivers of Sector Development Used to Select Interviewees

Number	Drivers of Sector Development
1	Regulatory/Governance/Policy
2	Cost of Production
3	Technological Development
4	Environmental Impacts
5	Protein or Alt-Protein Market
6	Geographical Distribution
7	Supply of Clean Energy
8	Consumer Response
9	NZ Business Dynamics and Response
10	Global Scale Challenges
11	Māori Development Opportunities

Interviews represented the first round of a Delphi style process. Given the focus on novel technologies, the Delphi model functioned to ensure a baseline of understanding across participants. Each participant was shown a brief video overviewing the global emerging protein landscape, with particular interest in plant-based, precision-fermentation, and cellular-agriculture technologies. Participants were then asked for their impressions of the information laid out in the video and their specific areas of interest, followed by questions regarding the current state of the sector, and the future opportunities and quandaries they envisaged.

For the central stream of this project, the knowledge generated from the first round of interviews was used to generate various scenarios for the future of land-use, following which a larger pool of participants were surveyed to provide comment and fine-tuning.

For the purposes of this report, however, only the interviews from the first round have been used due to the fact that this has been the qualitative component of the project. Interviews were coded using the themes generated in the media literature review: *The Lab of Milk and Honey: Discourses in Aotearoa New Zealand Media that Envisage a Synthetic Protein Future* (Sinclair-Thompson, 2022). While also premised on Helliwell and Burton (2021), using the themes from *The Lab of Milk and Honey* allowed for comparisons between media and expert discourses. Notably, however, *The Lab of Milk and Honey* focuses exclusively on synthetic proteins, which was the standard term used at the time to describe both lab-based cell-culturing and precision fermentation. From the initial themes, codes were adapted to better suit the nature of the interviews, which tended to be far more granular and future focused than media had been over the past decade, as such promissory narratives were split between the participants' perceived land-use shifts for each technology type. With regards to hypothetical absences, interviewees were far less concerned about the current aspects of today's world that technology could destroy, while the bulk of the interviews focused on the

absences in the worlds technologies could create, inflected through their particular areas of concern.

With regards to the significance of the voices, it should be noted that data for this report contrasts with the role of scenario modelling. While we intend to envisage the future through both aspects of the project, unlike in scenario modelling, this thematic analysis does not seek to define potential routes. Rather, the purpose of thematic analysis is to consider how the voices involved in the sector are formulating their vision-making. That is to ask how do actors construct their visions of the future, what areas are they focused on, and what appeals do they use to support their vision-making?

Likewise, the purpose of this report is not to provide conclusions, as in an empirical study, but rather to provide considerations for the kinds of discursive work being done in the sector. For this reason, while the voices involved in the project planning of a large farming cooperative may have very different implications for the making of the future than the voice of a freelance consultant, both sets of voices are significant for surveying the assemblage of the sector.

Promissory Narratives

Imagining the future entails a complex act of integrating multiple, often competing, drivers into an intelligible narrative. It is also a reflexive act, in that how drivers are conceptualised and balanced reveals something about the perspective of the imaginer, which might be considered in light of the role they perform. Many interviewees caveated their responses by acknowledging the complexity involved in the future focused questions, and made particular emphasis to frame their commentaries in the context of their perspective.

Unsurprisingly, a food futurist offered perhaps the most comprehensive example of an attempt to integrate complex drivers:

“I think it’s okay at the country level for us to play at the premium, at the middle market, and the commodity market, and that’s already what we do, I think the same will emerge for these emerging proteins is there will be some in the premium market there’ll be some in the middle and there’ll be some for you know early on I called it food for people with no choice, so: prisons, hospitals, old people’s homes.

There will be all of those markets will be covered and so the economics are different in those three markets, what the economics are in mass market it will make a real difference to what the inputs are, and we may find that marginal land that can be put into crops might be a great place for those providers. Whereas at a high end it might need to be regen or organic and so I think (...) it will be economic in multiple ways.

You know, farms already are diversified businesses and I think we should expect that this will be a diversified industry and there will be different drivers for different people so some of that economic one will also replace existing, either grass or crop or forests or meat or dairy at an environmental level we’ve already seen it with a bunch of the vertical farms in the US that their ability to do controlled indoor agriculture that is organic without pesticides and an absolute minimum of fossil fuel based fertiliser means that they can compete in a low-carbon economy, particularly when they use solar power and they walk their product to market, there’s a whole lot of efficiencies that come in for that vegetable and fruit production that makes it very climate friendly I think we will see products like that in the emerging proteins area where they will compete on, you know, what’s the emissions per kilo of protein or available protein.”

Demonstrated in the quote, the food futurist rhetorically suspends their identity so as to encapsulate the drivers from the projection of the ‘country level’, demarcating markets along the particular food-choice agency of their consumers given their social circumstances, and only then inviting us to consider the metrics that will determine the efficacy of the various

technologies to fit into this world of multiple niches. Already this is a fundamental different discursive terrain to say a linear progress narrative.

Plant Based

Inevitably, as the only technology currently in market in Aotearoa New Zealand Plant-based proteins attracted the most commentary. There was a general consensus amongst interviewees, with a few notable exceptions, about the potential to grow plant-based proteins, largely framed as a form of diversification, however, that could be approached in a number of ways. The following quote by an agricultural scientist displays a particular concern for the risks built into the current production system:

“Is there space and opportunities for New Zealand to grow [plant-protein]? The answer is yes as well, and particularly I think if the country wanted to diversify itself (...)

I see it as a mitigation strategy to reduce risk for the country as well, New Zealand cannot rely on meat and dairy forever, there is a huge risk around that even though it continues to sell well every year, (...) as a country, for its future, I think it's the risk mitigation strategy, for the country, it needs to go [to a] much more diverse agricultural production system.”

The emphasis on risk invokes the caveat of the unknown that comes with any future imagining. In this instance, the interviewee identified diversification as a mitigation strategy by facilitating the possibility of alternatives in the event any single system fails.

Whereas the above quote emphasised change from a country-scale perspective so as to emphasise the role of regulatory bodies in driving a coherent national economy, the following from a plant-based start-up put the farmer front and centre:

“For us it's about achieving scale, but doing that in a way that allows farmers to come on the journey with us, or we go on it together, so the way we envisage the farming system working now and it will as we work more closely with farmers, change over time, but adopting a fraction of their land into the (...) system that's dedicated to the plant protein supply for human consumption and then the co-product feed coming off that can go off into the animal system.

So it's not like this replacement type system, it's complimentary, and then as the market validation happens over time, or we can see that there's other benefits for whatever that cropping system or the loop (...) system provides, it can grow from there.

(...)

To that point one other thing is also seeing a big concern for processors going forward seeing as though we've reached peak milk and it looks to be going on a downward trajectory so designing our own system in the way in which we could integrate within the dairy system, albeit we do have some differences, but how do we utilise that stainless steel, that's probably going to have (...) greater capacity challenges.”

Firmly rooted in a farm-systems perspective, the quote demonstrates an approach to the issue of scaling up that attempts to fill in the gaps of an overextended pastoral agriculture via diversification, both on farm and in processing.

As far as drivers were concerned, the role of a government push as opposed to an innovation pull was an apparent duality for interviewees to negotiate, and upon which responses can be contrasted. To round out the two previous quotations, this from a financial advisor recognised the role of government regulation on farmer decision making:

“I think it has the potential for greater diversification and not just at an aggregate national level but within farming systems.

I think the basic economics around the costs we're imposing on livestock production to externalise some of their environmental impacts are discouraging further investment in that space and tipping it more to non-livestock production systems that don't have those costs so I think over time you know farmers will look at is there a proportion of my property that I can put into a crop for alternative proteins.

But again, I think it's still a relatively slow burn, so you know in the next couple of years maybe won't see massive uptake but then if you do look ten years out yeah more opportunities in that space.

I'm not sure at this stage that it's going to be a game changer for land-use or anything like that."

Precision Fermentation:

In contrast to the plant-based proteins, precision fermentation served as a truly novel terrain for many respondents. Though most had heard of developments overseas and many were well up to speed with market shifts, in the absence of direct industry involvement, interviewees had to make use of hypotheticals and analogies to construct their future imagining. The following quote from a former food-trends analyst attempts to integrate precision-fermentation into the Aotearoa New Zealand agrifood scape:

"By 2050 I think it's going to be a part of our commodity make-up, so you know at the end of the day you don't care right you're buying the milk to put into a chocolate bar (...) it's the same thing same cells same structures, all those things, it's the scalability that's stopping it from growing, globally regardless of New Zealand.

But I think in New Zealand we'll still farm but what will support us being able to farm will be the fact that we can take the volume, you know you might not have a milk curve, you might not do winter milking anymore (...), what do you do? You crank up your vats in winter and you do your cheeses and all your other things in summer when the production's coming in."

The quote demonstrates an attempt to turn precision fermentation into something legible for current dairy operations. The implication of the world commodity market turning to fermentation is that pastoral-based dairying fills a premium market, in which instance fermentation is predicted to supplement pasture as a means to facilitate de-stocking and a less intensive dairying. Several absences remain, however, for example how the dairy industry would survive off of an exclusively premium market, or how precision fermented and pasture-based dairy would sit alongside each other.

Carrying over from the plant-based commentary, the projected decline in stocking rates was expected to provide an opening to diversify processing, possibly to enable either precision-fermentation or cell-cultured proteins, as illustrated in the following quote from a financial advisor:

"In terms of that fermentation space, I think there is an opportunity here because (...), if we're anticipating based off climate change commission data that we're going to have a 12% decline in sheep and beef stock units in New Zealand by 2030, we're going to have to run into issues around processing capacity, we've had an overprocessing supply the last few years, but now with labour shortages that's somewhat improved, so I think meat companies are going to have to start looking particularly in the sort of Gisborne area and through Otago we're going to see ongoing land-use pressure for change to trees, what do we do with all our processing facilities, what do we turn those into?"

And the dairy industry may face some of these questions, but not to the same extent as the sheep and beef industry, what do you do with all the infrastructure you've got there: those plants, the staff? And [there] could there be an opportunity for investment or changing your infrastructure to be able to ferment or harvest, [to] provide a component of that cellular production that we export. So I think there could be some opportunities in there, and I think it's going to be up to the science community to help identify what those products could be and then working out whether there is actually sufficient financial incentives there for it to stack up really."

As with the start-up interviewee, this advisor seeks to mobilise processing capacity so as to prompt diversification, recognising, however, that research will need to be done into the ability for such systems to transition, and the financial impacts of doing so.

Cell Cultured:

Of the three emerging protein domains discussed, cell cultured was the furthest from all the interviewees concern, both because of the distance to the industry and the fact the technology has yet to be proven as commercially viable. That being said, interviewees were cognisant

of the potential as a hypothetical entity, and a few attempted imaginative, though heavily caveated pathways. The following quote came from a former food-trends analyst:

“So if you look at it from a cellular base (...) you could run a farm with three cows, or three bulls or whatever because the cells in which we use them you just need to keep the progeny going then obviously that will have a huge environmental impact because I can still eat 7 steaks a week and you know each farmer only has to keep 2-3 cattle, because they’re actually like a stock for quality cell-stock you know they’re not a big farm stock thing.”

While the need for pasture-based meat to supply cell-cultured protein remains to be seen, should the technology take off using immortalised cell lines, the quote does demonstrate an increased emphasis on progeny as a potential driver for the future of the meat industry.

In a more hesitant tone, a plant-based protein start-up advisor sketched out their concerns, though in doing so considered the possible utility of the technology as well:

“The other reason why I'm sort of a little bit eerie around the whole cultivated meats area, is it doesn't feel like it's a space where NZ itself has any comparative advantage. We're a long way away from markets.

I mean, maybe it has for feeding our own people, and that's an important consideration, don't get me wrong, but it's certainly not the scale that our industry is, which exports most of its produce. So thinking about because we're sort of an export growth, business growth, economic development space. considerations, are where is the consumer for this is a suitably big enough for the market to make the process worthwhile.”

While acknowledging the technology is still far from being realised, the interviewee demonstrates in the quote that their own inability to conceive of Aotearoa New Zealand successfully implementing a cell-cultured industry impedes them from imagining a positive vision for the technology. That said, the prospects of a local-cell-cultured industry, provides a novel discussion point. Without elaboration, the point raises questions as to what would have to happen to Aotearoa New Zealand pasture to prompt such a development.

Conclusion

This introductory report served the aim of instantiating a mechanism of analysis through which to approach the future vision making of actors in the emerging protein sector and their adjacents. While this report only offered a snapshot of the voices in the space, already it demonstrates some of the processes by which actors are conceiving of the future of land-use such as:

- integrating regulatory and innovation drivers,
- relating the Aotearoa New Zealand agrifood scape to competitors overseas, and
- exploring opportunities for diversification as a means to fulfil national interests in a more complex food future.

What was evident throughout interviews is that the technologies each correspond to very different sets of mechanics and so implicate very different, though not necessarily mutually exclusive, futures. From the data collected for this project there is more work to be done analysing actors’ formulations for the drivers of change, as well as the creative and destructive silences unmentioned in their responses.

References:

- Burton, R. J. F. (2019). The potential impact of synthetic animal protein on livestock production: The new “war against agriculture”? *Journal of Rural Studies*, 68(March), 33–45. <https://doi.org/10.1016/j.jrurstud.2019.03.002>
- EPNZ. (2021). *Emerging Proteins in Aotearoa New Zealand: What will it take for the sector to thrive?*
- EPNZ. (2022). *Government investment in the opportunities of alternative proteins.*
- GFI (2022). *Alt Protein Market Saw Record \$5B in 2021 Investment.* Good Food Institute press release. <https://www.foodmanufacturing.com/capital-investment/news/220936>
- Helliwell, R., & Burton, R. J. F. (2021). The promised land? Exploring the future visions and narrative silences of cellular agriculture in news and industry media. *Journal of Rural Studies*, 84(January), 180–191. <https://doi.org/10.1016/j.jrurstud.2021.04.002>
- MFE and Stats NZ, (2021). *New Zealand's Environment Reporting Series: Our Land 2021.* Wellington: Ministry for the Environment & Stats NZ.
- Morach, B., Witte, B., Walker, D., von Koeller, E., Grosse-Holz, F., Rogg, J., Brigl, M., Dehnert, N., Obloj, P., Koktenturk, S., & Schulze, U. (2021). Food for Thought: The Protein Transformation. *Industrial Biotechnology*, 17(3), 125–133. <https://doi.org/10.1089/ind.2021.29245.bwi>
- OECD and FAO. (2021). *OECD-FAO Agricultural Outlook 2021-2030.* OECDiLibrary: OECD-FAO.
- Sinclair-Thompson, A. (2022). *The Lab of Milk and Honey : Discourses in Aotearoa New Zealand Media that Envisage a Synthetic Protein Future Centre for Sustainability Discussion Paper February 2022: 6, 1–54.*