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Cellular Agriculture's Role in Diversifying Food Exports for Aotearoa New Zealand

how can we optimise our policy and regulatory settings for opportunities in future foods?

Abstract

Cellular agriculture is an emerging form of food production which aims to ethically and sustainably meet increased food demands in a fast-changing world. This article explores key regulatory challenges associated with this new industry, alongside opportunities and potential pitfalls in our uniquely Aotearoa New Zealand context. Existing regulatory frameworks around the world are explored, building a picture of a varied policy landscape influenced by strongly held political attitudes towards food and food production. To maximise the promise of this potential new export market for Aotearoa New Zealand, policymakers need to ensure that regulation is safe, efficient, well communicated and responsive to less visible sociopolitical needs.

Keywords alternative proteins, future foods, cell-cultured meat, cellular agriculture, novel food safety, sustainable agriculture

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Context

It has long been recognised that Aotearoa New Zealand's primary industries and food export economy are a source of both vulnerability and future opportunity for New Zealand (Ministry of Research, Science and Technology, 2003, 2005). Food exports made up about 67% of New Zealand's total export goods in 2023, with our two largest food exports dairy and meat respectively (Ministry for Primary Industries, 2023). New Zealand is the largest single-country exporter of milk products in the world (Te Puna Whakaaronui, 2022). Our economy's reliance on the sector means future shocks stemming from breakthrough technologies, increasing extreme weather events, animal disease epidemics, evolving consumer preferences and geopolitical tensions all pose an outsized threat to our economy (Ministry for Primary Industries, 2023; Te Puna Whakaaronui, 2022). Diversifying our food export offerings affords an opportunity to improve the resilience of our export market while leveraging existing expertise and infrastructure. Diversification can also provide new opportunities for high-value jobs.

New forms of protein production provide an opportunity to diversify without necessarily undermining our existing primary industries, particularly as new export markets open and younger generations show increasing interest in alternative food sources (Food HQ, 2023; Ministry for Primary Industries (MPI), 2023; Te Puna Whakaaronui, 2022). Although New Zealand has historically put limited funding into the alternative protein space (Food HQ, 2023), our level of investment has increased significantly in recent years, surpassing US$28 million in 2024 (GFI, 2025), including investment in cell-based products. Cell-based products are already widely used for cellular therapy and regenerative medicine applications (Ganesan et al., 2025), and this expertise is now being applied to the agrifood sector. Here, we interrogate the opportunities and risks specifically associated with cell-based food products, and address how we might adapt our regulatory and policy frameworks to support this emerging industry.

The rise of 'future foods'

As the global population expands, the interest in using technology to enhance food production grows, with a particular interest in proteins. The size of the global challenge to produce high-quality proteins is formidable, as noted recently by the EAT-Lancet Commission (Rockström et al., 2025; Rosin and Campbell, 2024). A variety of alternative protein sources are produced internationally: a basic overview is shown in Table 1. To meet this challenge will require multiple solutions to meet different market niches, and here we focus on one of them – cellular agriculture. McKinsey and Company recently estimated that the global market for cell-based or cellular agriculture products alone could be worth up to $320 billion by 2050 (Cellular Agriculture Australia, 2025).

Table 1: Protein types currently being explored as alternative protein sources to those extracted from traditional animal agriculture

Alternative proteins			
Plant-based proteins	Cell-based proteins (cellular agriculture)		Other proteins
	Acellular proteins (no cells in product)	Cellular proteins (product contains cells)	
· Legumes · Cereals · Seeds · Leafy greens (Rubisco)	· Animal cell-cultured proteins (milk / egg) · Precision fermentation* · Molecular farming*	· Animal cell-cultured proteins (meat / seafood) · Biomass fermentation (e.g. mycoproteins, microalgae)	· Insects · Seaweed
Hybrid (or blended) products can be formed by combining different protein sources (including conventional proteins).			

*Requires genetic engineering of inputs
Source: Food HQ, 2023; Te Puna Whakaaronui, 2022

What is cellular agriculture?

Cellular agriculture, where agricultural products are formed through cell culture (Martins et al., 2024), is emerging as an alternative to conventional farming methods. Although production costs today are higher than for plant- and fungi-based products, cell-cultured products can more accurately replicate the taste, texture, appearance and aroma of a diverse range of existing products, including meat, dairy and egg proteins (FAO and WHO, 2023a; Kaplan and McClements, 2025). Cellular agriculture can also be used to create breast milk for infants, animal-based materials such as leather, and non-animal products, including coffee and cocoa (Cellular Agriculture Australia, 2025; FAO, 2023). Cell-cultured meat[1] is produced by growing animal cells inside environmentally controlled 'bioreactors',[2] replicating the processes responsible for muscle and fat growth in live animals (Kaplan and McClements, 2025; Martins et al., 2024). During production, cells may be attached to edible biomaterial

Figure 1: A general overview of process stages and associated technical and scaling challenges within cell-cultured production

Cell sourcing	Cell expansion	Biomass harvesting	Biomass processing
Procedures			
· Tissue sampling · Cell isolation · Cell storage	· Initial cell culture · Large-scale culture · Cell differentiation	· Cell maturation · Cell collection · Scaffold removal*	· Formulation · Packaging · Storage
Current technical and scaling challenges			
· High cost of cell banking	· High cost of growth media · Large quantity of biomaterials required for feedstock and edible scaffolds	· Incomplete nutritional and flavour profiles	

*If inedible scaffold materials are present during expansion
Source: image adapted from FAO and WHO, 2023a. Procedures and challenges from Bennie et al., 2025; Gordon et al., 2025; Martins et al., 2024

'scaffolds' to structure their growth. Use of scaffolds can reduce production cost and improve the quality of the resulting 'hybrid' (or 'blended') product (Gordon et al., 2025; Kaplan and McClements, 2025). Touted as a highly secure, sustainable and ethical means of producing convincing animal protein substitutes (ibid.), cellular agriculture nevertheless faces as yet unresolved technical challenges throughout its production life cycle, shown in Figure 1.

International public investment in the cellular agriculture industry has helped to encourage significant growth across the sector over the past decade (GFI, 2024, 2025). The first cell-cultured bovine meat was produced at Maastricht University in 2013, with a price tag of over NZ$1 million per kg (Te Puna Whakaaronui, 2022). Since then, the cellular agriculture industry has grown considerably, with over 250 companies active in the cell-cultured protein space in 2026 (GFI, 2026); investment from multinational food producers include Tyson Foods, Nestlé and Cargill, and bovine meat produced at less than NZ$100 per kg (Food HQ, 2023; Te Puna Whakaaronui, 2022). Cell-cultured beef products could feasibly reach a competitive price point once serum-free media costs drop below US$0.75 per litre, with past industry-backed predictions forecasting cell-cultured meat prices becoming competitive as early as 2030 (Negulescu et al., 2023; Vergeer et al., 2021).

However, as few commercial-scale cell-cultured production facilities currently exist, cell-cultured products are not widely available for purchase, and it is difficult for cellular agriculture companies to establish sustainable revenue streams. Outside of limited tasting events and restaurant dining, hybrid cell-cultured meat products designed for human consumption are currently only available for purchase in Singapore and Australia (GOOD Meat, 2026; Vow, 2026); cell-cultured products have not yet been consumed in New Zealand. With a more challenging landscape for private investment post-Covid-19 as well, the international research and start-up ecosystem has become highly volatile, with new start-up companies emerging as more established cultivated meat companies shut down operations (Watson, 2025; Protein Trends, 2026). Indeed, it has been suggested that after a period of unrealistic expectations, investor sentiment towards cellular agriculture is sitting within a 'trough of disillusionment', despite continued innovation (Fino et al., 2024; McNulty et al., 2025).

Hazards associated with cell lines include misidentification or cross contamination, contamination with microbial pathogens or contamination with chemical residues.

This dynamic landscape presents a challenge for regulators and compounds the risk that innovation is compromised by regulatory delays, creating significant barriers to scaling. Responsive design and implementation of regulation can help enable and promote innovation while protecting consumers (Fino et al., 2024; Monaco, 2025a). For example, the scaling of hybrid meat production requires supply chains for large quantities of biomaterial ingredients. These ingredients could be supplied through lower-value byproducts from our conventional agrifood industries (Glaros, 2025; Gordon et al., 2025). Robust and efficient safety evaluation of new sources of biomaterials can help progress the development of these supply chains, especially when approvals are coordinated with other regulatory agencies. Scaling also requires equipment that is food-grade rather than medical-grade, and regulators can provide useful insights into food-grade standards as companies scale up their facilities (Te Puna Whakaaronui, 2022).

Key questions for regulators

The challenges associated with cellular agriculture are common for production processes still in the early stages of technological development, with limited presence at a commercial scale. Here, we discuss some of the major questions about the emerging industry being asked by regulators worldwide.

How can we ensure cell-cultured products are as safe to consume as other foods?

Internationally, the principle of substantial equivalence is generally applied: the safety of novel foods is determined through comparison with foods produced conventionally. Novel foods must meet the same food safety standards as currently commercialised food products, including effective management of novel hazards (FAO and WHO, 2023a). Although food safety risks associated with cell-cultured products are generally similar to those of other food products, the unique production process and the use of new food ingredients, such as cell lines, growth media and scaffold materials, each introduce novel hazards. These hazards[3] include new avenues for microbial contamination and new sources of chemical toxicity and allergenicity (Kaplan and McClements, 2025). Hazards can be managed using good hygiene practices coupled with international systems for food safety management, a primary example being the Hazard Analysis and Critical Control Points (HACCP) approach. The principles of HACCP are set out in the Codex Alimentarius Code of Practice: hazards should be identified, monitored with regard to established safe limits, and reduced or eliminated via control measures (FAO and WHO, 2023b; Manning, 2024).

Ensuring the widespread adoption of standardised measures to identify and control novel hazards requires industry transparency and close cooperation between researchers, companies and regulatory bodies. Efforts are underway to systematically categorise hazards by type and origin (FAO and WHO, 2023a) and document appropriate mitigation methods. Hazards associated with cell lines include misidentification or cross contamination, contamination with microbial pathogens or contamination with chemical residues.

The risk these hazards present can be controlled through standardised cell banking, monitoring the health of source animals, and routine cell line testing for biological or chemical contamination (Bennie et al., 2025; Semper et al., 2024; Sun et al., 2024). Media components used for cell culturing should also be assessed to determine maximum safe limits on residue present in the final product (Huang et al., 2024; Ong et al., 2025). Novel allergen risks can arise from genetic modification of cell lines or cell culture-induced changes in gene expression (Bennie et al., 2025), or from the addition of allergenic media and scaffold components.[4] Proteins in cellular products that differ from those in conventional meat can be considered as potential novel allergens and subjected to further allergenicity testing (Ham et al., 2025).

How can we ensure cell-cultured products are labelled appropriately for purchase/export?

The presence of cell culture ingredients in food must be clearly communicated to the consumer, who needs to understand the difference between these new offerings and traditional produce. For instance, the presence of macronutrients (e.g., protein, fat), micronutrients (e.g., iron, vitamin B_{12}), and their digestibility and bioavailability may differ significantly between cell-cultured and conventional ingredients (FSANZ, 2025a; Gordon et al., 2025; Kaplan and McClements, 2025). Thus, cell-cultured ingredients should be clearly distinguished from conventional equivalents to enable consumers to recognise important nutritional differences and respond appropriately. Distinctive labelling should also highlight differences in storage, shelf-life or preparation requirements existing between cell-cultured and conventional products (FSANZ, 2025a; Hocquette et al., 2025). The risk that those allergic or hypersensitive to conventional meats may inadvertently consume cell-cultured equivalents should also be mitigated. Allergens and nutritional differences may need to be highlighted or featured prominently to educate consumers as products become available for purchase (FSANZ, 2025a; Hallman et al., 2023).

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How does the environmental footprint of cellular agriculture compare with conventional agriculture?

The environmental impacts of cell-cultured meat production have previously been compared with those from conventional meat production through a variety of life cycle analyses (LCAs).[5] Recent LCAs indicate that the production of cell-cultured meat can have reduced environmental impacts relative to conventional beef (Kossmann et al., 2025; Sinke et al., 2023; Tuomisto et al., 2022), but also demonstrate that there is a non-negligible risk of cell-cultured meat production having a greater environmental impact than conventional meat production overall (Risner et al., 2025; Tuomisto et al., 2022). Regulators and policymakers should therefore carefully interrogate environmental claims, which are critically dependent on the estimates used and the boundaries of the analysis for both traditional and cell-cultured products. Recent LCAs typically exclude elements of the full production process from comparisons between conventional and cell-cultured meat, including the construction of industry facilities and equipment, as well as packaging, storage and transport of products (ibid.). They do not always consider regional variation in agricultural systems and innovation in agriculture practices, such as regenerative farming (Hocquette et al., 2025; Kossmann et al., 2025). Broader sustainability considerations, such as antimicrobial resistance risk, biodiversity and ecosystem impacts, food security, food sovereignty, and the flow-on benefits of traditional agriculture, are also absent from recent LCAs (Glaros, 2025; Risner et al., 2025; Sinke et al., 2023).

Despite their limitations, LCAs provide useful guidelines for the responsible development of new industrial processes. LCAs and techno-economic assessments in a New Zealand context would be a valuable resource for local decision makers while industry presence remains limited (Semper et al., 2024). It should not be assumed that all cellular agriculture will have a net environmental advantage over all forms of conventional agriculture; depending on the approach used, cellular agriculture may present environmental advantages over some forms of farming but not others (Sinke et al., 2023). Therefore, LCAs can be useful to identify interventions that improve future environmental outcomes. From recent LCAs, it appears that potential environmental benefits of cell-cultured production over conventional meat rely heavily on industrial-scale design decisions. For example, operating bioreactor systems with renewable energy and seawater cooling can significantly reduce their net environmental footprint (Fino et al., 2024; Tuomisto et al., 2022). The cost of resources used to produce culture media ingredients can also be greatly reduced by building new supply chains for sustainable media formulations – for example, those that incorporate food industry by-products (Kossmann et al., 2025; Sinke et al., 2023).

Table 2: Food safety authorities and standards for non-GM cell-cultured foods in jurisdictions with specific mention of cell-based products (or foods produced from cell culture) in their food safety laws or regulations

Jurisdiction	Authority responsible for food safety assessment	Safety regulations for cell-cultured food	Cell-cultured food approved for human consumption?
Australia and New Zealand	Food Standards Australia New Zealand (FSANZ)	Australia–New Zealand Food Standards Code: Standards 1.5.4 and 3.4.1, Schedule 25A	Yes (2025)
Singapore	Singapore Food Agency (SFA)	SFA's Requirements for the Safety Assessment of Novel Foods and Novel Food Ingredients (2019)	Yes (2020)
South Korea	Ministry of Agriculture, Food and Rural Affairs / Ministry of Food and Drug Safety	Ministry of Food and Drug Safety Public Notice No. 2024–13	No
Hong Kong SAR	Hong Kong Food and Environmental Hygiene Department – Centre for Food Safety	CFS's Technical Guidance Notes on the Safety Assessment of Cultured Meat (2025)	Yes (2024)
United States of America	Food and Drug Administration (FDA) / Department of Agriculture Food Safety and Inspection Service (FSIS)	Specific regulatory regime described in the formal agreement between FDA and USDA (2019)	Yes (2023)
Brazil	Brazilian Health Regulatory Agency	Collegiate Board Resolution (RDC) 839/2023 (the 'New Food Safety Guidelines')	No
European Union (EU) / European Economic Area (EEA)	European Food Safety Authority	Regulation (EU) No. 2015/2283 (the 'Novel Food Regulation')	No
Switzerland	Federal Food Safety and Veterinary Office	Federal Act on Foodstuffs and Utility Articles (Regulation 817)*	No
United Kingdom	UK Food Standards Agency / Food Standards Scotland	Standards currently harmonised with EU Regulation 2015/2283	No
Israel	Ministry of Health – National Food Services	Novel Food Directive 2006 (No. 004-08)	Yes (2024)

*Based on EU framework for novel foods
Source: assessing authorities and retail approval dates from GFI, 2024, 2025; FSANZ, 2025a

How have regulators responded internationally?

Progress in developing regulatory frameworks and standards for cellular agriculture has been uneven between jurisdictions across the globe. Policy responses remain limited to a small number of countries with financial or strategic interests in cellular agriculture, while most countries lack substantive rules for the industry (GFI, 2025). More advanced frameworks entail a risk analysis approach that takes into account public health, safety and consumer protection, involving evidence-based risk assessments prior to political authorisation (Monaco, 2025b). However, there exist significant points of difference across even the most mature frameworks, reflecting ongoing uncertainty about the future impacts of new cellular agriculture technologies (Johnson and Monaco, 2025). Both the immediate political context, as well as the extent to which regulators engage with industry and the public, influence regional approaches towards novel foods (Monaco, 2025b). See Table 2 for a summary of legislative responses to the emergence of cellular agriculture to date.

In Singapore, the first country to approve cell-cultured products for sale, cellular agriculture is managed under their novel food regulations (GFI, 2024). The Singapore Food Agency (SFA) set out an initial set of guidelines for pre-market approval of novel foods in 2019, then updated them in 2023 (SFA, 2023). Early adoption of these guidelines was driven by Singapore's '30 by 30' national food security strategy aimed at increasing local agricultural production (Johnson and Monaco, 2025). The guidelines give a detailed overview of required information from the safety assessment of cell-cultured meat, covering cell lines, culture media, scaffolding materials and a range of other inputs. Formal legislation for the regulation of novel food production was passed in 2025 to provide further regulatory clarity and certainty. The Act requires pre-market approval by the SFA for the production, import, distribution or sale of 'defined foods' within Singapore, covering both novel and genetically modified foods (GFI, 2025; Johnson and Monaco, 2025). The approval process takes into account 'public health and safety considerations', such as hazards arising from the source, production or final composition of the food (Johnson and Monaco, 2025). Most jurisdictions with an active cellular agriculture industry also manage cellular agriculture products through their novel food regulations, including the EU and Israel.

In contrast, the US has opted to create a pathway for cellular agriculture products that sits outside an existing novel food framework (Bennie et al., 2025; Johnson and Monaco, 2025). Rather than take a 'top-down' regulatory approach to encourage industry growth as in Singapore, this framework is a 'bottom-up' response to the growth of industry out of the existing US biotechnology ecosystem (Grossman, 2019; Stephens et al., 2019). This regulatory approach more closely matches that applicable to conventional meat products (Manning, 2024), where the Food and Drug Administration (FDA) assesses tissue collection, cell lines, cell banks, components and inputs, while the Food Safety and Inspection Service (FSIS) regulates production facilities, post-harvest processing, packaging and labelling (Bennie et al., 2025; Giglio et al., 2024). Note that only cell-cultured products with conventional equivalents regulated by the Department of Agriculture fall under this framework, covering meat, poultry and catfish. Unlike Singapore, the US does not to date provide specific guidelines describing the process for safety approval, although the FDA and Department of Agriculture plan to announce additional guidelines in future that provide greater clarity. It is likely that US regulations will continue to change as more applications are processed (Johnson and Monaco, 2025).

Several jurisdictions have established regulatory 'sandboxes' to better understand the future role of regulators once cell-cultured products are approved for sale locally. The South Korean government established the Gyeongbuk Regulatory-Free Special Zone for Cultivated Food in 2024, allowing ten participating cellular agriculture companies to establish cell banks and explore product commercialisation through demonstrations and tastings (GFI, 2025). Exemptions for tastings of cellular agriculture products are also available in other jurisdictions, such as the Netherlands (Rijksoverheid, 2023; Staten-Generaal, 2025). In 2025, the UK government launched a limited-time regulatory sandbox for cell-cultured meat, involving eight cell-cultured food companies, three academic organisations and two non-profit partners. UK food regulators plan to gather safety and nutritional data from participating companies for use in developing future regulation, alongside completing full safety assessments of two existing cell-cultured products (FSA, 2025). Regulatory sandboxes can provide a useful forum to facilitate communication and collaboration between industry and regulators, helping early-stage companies navigate complex approval processes and reduce the costs associated with employing third-party consultants (Monaco, 2025b; Reinhardt and Monaco, 2025).

Alternative approval pathways exist in jurisdictions where cell-cultured foods are not currently approved for human consumption. Pet foods containing cell-cultured meat are already allowed onto the market in the EU and UK (EU Feed Chain Task Force, 2026). Through a multi-agency collaboration between the UK Food Safety Agency (FSA), the Department for Environment, Food and Rural Affairs, and the Animal and Plant Health Agency, the UK also approved a hybrid cell-cultured product for sale as pet food in 2024. This alternative regulatory pathway is governed through the UK's animal by-product regulations rather than its novel food framework (Gordon et al., 2025; Meatly, 2024). Pet foods with cell-cultured ingredients have also been sold in jurisdictions where cell-cultured foods have previously been approved for human consumption (Green Queen, 2026). Alternative regulatory pathways can significantly reduce the time to market for cellular agriculture products, ensuring that companies can secure revenue while continuing to scale.

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Political opposition to 'unnatural' cell-cultured products has led to prohibitions on cellular agriculture products in some regions. These bans are often supported by agricultural lobbyists, who may see cellular agriculture as an economic threat to 'authentic' production or as a cultural threat to their national food heritage (Fino et al., 2024; Hocquette et al., 2025; Monaco, 2025a). In the EU, there have been national prohibitions in place in Italy since 2023 and Hungary since 2025 (GFI, 2025; Hungary Today, 2025), and bans have also been proposed by lawmakers in Romania, Austria and France (Fino et al., 2024; GFI, 2024). In the US, cell-cultured meat bans were enacted in Florida and Alabama in 2024 (Gerber et al., 2025), while Texas, Indiana, Mississippi, Montana and Nebraska passed their own bans in 2025 (GFI, 2025; Smith-Schoenwalder, 2025). While the federal administration in the US has a benign attitude towards state-level bans (Smith-Schoenwalder, 2025), the European Commission has argued that bans by EU member states are 'unjustified' and potentially unenforceable (GFI, 2025). State and country-level bans in both the EU and US are also being challenged in court by industry and advocacy groups (GFI, 2024).

How have our local food safety authorities responded to date?

In 2023, the joint Australia–New Zealand regulator Food Standards Australia New Zealand (FSANZ) began assessing the first application for approval of a cell-cultured product. The regulator initially intended for the product to be regulated under novel food standards within their Food Standards Code (GFI, 2024; Monaco, 2025b). However, after two rounds of public consultation, FSANZ created a separate regulatory pathway for pre-market clearance of cell-cultured products, introducing new standards 1.5.4 and 3.4.1. These safety standards regulate production of cell-cultured foods[6] throughout the supply chain, covering 'inputs, premises and equipment, processing protocols, monitoring and verification' (FSANZ, 2025a, 2025c). Standard 1.5.4 requires the use of 'cell-cultured' and 'cell-cultivated' on labels for food containing a cell-cultured ingredient (FSANZ, 2025c), as 'consumer evidence indicates both terms perform equally in relation to consumers' objective understanding, descriptiveness of the food and perceived allergenicity' (FSANZ, 2025a). The use of secondary legislation to specifically regulate cell-cultured foods differs from the more informal guidance issued in the US and Singapore (Table 2).

After approval by the FSANZ board in April 2025 and with no objections from the Australian and New Zealand food ministers (FSANZ, 2025a, 2025b), amendment no. 239 was gazetted in New Zealand in June 2025, permitting the use of cell-cultured quail cells in food and paving the way for streamlined future approvals of cell-cultured foods (FSANZ, 2025d; New Zealand Gazette, 2025). While cell-cultured products are being produced for retail purchase in Australia (Vow, 2026), cell-cultured foods have not yet been produced or sold in Aotearoa New Zealand. Alongside regulatory approval from FSANZ, cell-cultured products must comply with other New Zealand-specific food regulation frameworks before they can be produced or sold locally or to export markets. These frameworks include risk management requirements for food businesses, consumer rights laws, animal welfare laws, biosecurity requirements, rules around food imports and exports, gene technology regulations and our responsibilities under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Australian Government, 2022; Department of Agriculture, Fisheries and Forestry, 2026; Ministry for Primary Industries, 2024). Existing settings will require review to ensure that they are appropriate for the future management of cell-cultured products.

What are the unique opportunities and risks in an Aotearoa New Zealand context?

New Zealand's role as an exporter of high-value primary products has historically led to significant investment in our biotechnology sector (Ministry of Research, Science and Technology, 2005). After the signing of a science partnership agreement between New Zealand and Singapore in 2019 (Ministry of Business, Innovation and Employment, 2025), an ongoing joint programme on future food research was established in 2020 through the Catalyst Fund (Ministry of Business, Innovation and Employment, 2020). This research partnership has helped to foster an emerging alternative protein industry in New Zealand alongside start-ups such as Leaft Foods (Rubisco) and Daisy Lab (precision fermentation). While the costs associated with bioreactor installation and operation at scale are major barriers to cell-cultured production in a relatively small economy (Te Puna Whakaaronui, 2022), our existing food sector expertise gives us opportunities to develop valuable intellectual property in this space (Food HQ, 2023; MPI, 2023). Furthermore, since cell lines and scaffolds derive from traditional agricultural production, New Zealand's reputation for high-quality primary products provides us with a strong value proposition as a business-to-business supplier for the cellular agriculture industry (Cellular Agriculture Australia, 2025; Food HQ, 2023). The only New Zealand company currently active in this space, Opo Bio, has a business model producing cell lines sourced from high-quality New Zealand livestock as a value-add component for cellular agriculture products (Food HQ, 2023).

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Another major local advantage is New Zealand's responsive regulatory framework for the production and sale of cellular agriculture products. While New Zealand has relatively stringent laws for domestic food production using genetic technologies, cell-cultured production does not always require genetic engineering to occur. In contrast to other jurisdictions, New Zealand has a relatively short time frame for approval, with typical novel food applications taking 15 months to be approved compared with an average of 37 months in the EU. FSANZ also has a relatively high level of engagement with applicants, with one sector representative noting that regulators 'make themselves available to companies to have a pre-application conversation so you can actually get a sense of how much information they're going to need' (Monaco, 2025b). Despite the shorter approval time frame, FSANZ considers a more rigorous list of factors in their approval process than regulators in jurisdictions such as the EU, US and Singapore; and Australia-New Zealand is the only jurisdiction to date requiring formal public consultation as part of the approval process for specific cell-cultured products (Johnson and Monaco, 2025). The relative efficiency of the FSANZ consultation process, despite its scope, provides advantages for local innovation, while building public trust (Monaco, 2025b). Further efforts to streamline the process of food safety application and approval may afford a competitive advantage for local companies.[7]

Capitalising on these advantages will require open conversations with consumers and a willingness to consider their concerns. Potential sources of public mistrust include quality, safety and ethical concerns regarding a new cell-cultured product, and social, cultural and economic concerns around the impacts of an emerging cellular agriculture industry (Tsvakirai et al., 2023). Religious consumers may also have concerns around whether ingredients used in cell-cultured food are halal or kosher (GFI, 2025; Hocquette et al., 2025). Quality concerns include questions around the sensory properties, value for money, healthiness and naturalness of the new food, including whether the food can be considered 'ultra-processed' and whether it contains food additives or genetically modified organisms (FSANZ, 2025a; Gordon et al., 2025; MPI, 2023). To maintain public trust, it is essential that effective mechanisms exist for consumers to provide feedback on regulation of this new technology on an ongoing basis.

As is the case for conventional agriculture, it is likely that the major audiences for a local cellular agriculture industry are offshore and exist as part of specific market niches (MPI, 2023), meaning that it is important to develop an accurate picture of consumer sentiment in different jurisdictions. Awareness of markets that will welcome our produce is required to develop a detailed understanding of local regulatory requirements for imported cellular agriculture produce. The limited availability of cell-based foods to date has led to a lack of comprehensive sensory studies, although robust frameworks exist for these studies as cell-cultured products become available (Gordon et al., 2025; Semper et al., 2024). Initial consumer surveys show that those most willing to try cell-cultured products are likely to be younger, male, and have low food neophobia and some awareness of cellular agriculture (Table 3). It should be noted that there has not yet been a consumer survey undertaken that specifically examines Māori or Pasifika views towards cellular agriculture (FSANZ, 2025a).

While consumer attitudes towards cell-cultured products remain changeable, domestic manufacturing and consumption of cellular agriculture needs to develop in the context of open conversations about this new technology (Rosenfeld and Tomiyama, 2023). Global consumer surveys show that a lack of awareness of the technology and a perception of unnaturalness fuels mistrust of cellular

Table 3: A sample of recent surveys on consumer acceptance of cell-cultured meat with N>500 total participants

Survey	Locale	Demographic categories	Sample size (year collected)	Key findings for cell-cultured meat (CM) (WTT – willing to try, WTP – willing to purchase, WTE – willing to eat)
Wendt and Weinrich, 2025	Germany	Gender, age, education, income, location, dietary habits	1099 (2024)	55.0% had positive levels of trust in CM, 24.3% would not purchase Most accepting group younger, more educated, with higher incomes and lower food neophobia
Lwin et al., 2025	Singapore	Gender, age, education, marital status, income, dietary habits	2000 (2023)	CM acceptance higher among those younger, male, less educated, with lower incomes, with lower food neophobia and higher CM awareness
Proi et al., 2025	Italy	Gender, age, education, location, dietary habits	800 (2023)	49.4% 'definitely' or 'probably' willing to try CM, 14.4% 'definitely not' WTT / WTE group younger, male, eat meat, have higher CM awareness, highly value meat, have a positive perception of cell-cultured benefits WTT less likely for those with conservative viewpoints
Chia et al., 2024	Singapore	Ethnicity, gender, age, education, income, dietary habits	1224 (2021–22)	25% 'very likely' or 'likely' to consume CM, ~15% 'very unlikely' to consume CM Acceptance of CM higher among male consumers, those with low food neophobia, those with higher CM awareness Acceptance lower among women and ethnic Malays; perception of unnaturalness strongest barrier to consumption, along with distrust of gene technologies
Melios and Grasso, 2024	United Kingdom	Gender, education, religiosity, political ideology	802 (2020)	Cluster of respondents who consumed more meat (meat 'fans') were less WTT or WTP hybrid meat than cluster who consumed less meat (meat 'reducers') 'Fans' preferred hybrid meat products containing beef, while 'reducers' preferred those containing chicken
Tsvakirai et al., 2023	South Africa	Ethnicity, age, education, income, location, dietary habits, family structure	658 (2022)	WTP higher among younger consumers, those with low food neophobia Concern about meat quality was found to be the largest barrier to acceptance, followed by concerns around impacts on the economy and primary sector
Giezenaar et al., 2023	Aotearoa New Zealand	Ethnicity, gender, age, income, location, dietary habits	572 (2021)	67% were willing to try CM WTT higher among those younger, male, those with low food neophobia, those with higher CM awareness, more regular consumers of plant-based meat alternatives, less regular consumers of meat

agriculture (Table 3), potentially resulting in a similar backlash to that previously seen for genetically modified food products (Gerber et al., 2025; Glaros, 2025; Hocquette et al., 2025). This type of backlash may be harnessed for political leverage, leading to attempts to limit the adoption of new technologies regardless of their merits or evidence for harm (Gerber et al., 2025; Monaco, 2025b). Transparency between industry, regulators and the public is key to building trust, instead of keeping information siloed (Fino et al., 2024). Some advocates have suggested that as public familiarity increases, public concerns can be lessened by emphasising the ethical and environmental issues involved with conventional agriculture (Rosenfeld and Tomiyama, 2023).

A sustainability framing risks creating unnecessary conflict between the alternative protein industry and sceptical farming communities (Briggs, 2017; Fowler, 2017). In turn, this approach could encourage lobbying by agribusiness against alternative protein companies (Monaco, 2025b). It should also be recognised that there are tangible environmental and social benefits that emerge from livestock farming, particularly in terms of sustaining rural populations (Hocquette et al., 2025; Nath et al., 2025). In New Zealand, cooperation could be fostered between the two industries – for example, encouraging the implementation of decentralised cellular agriculture within existing farms – bringing new opportunities to farming communities (Glaros, 2025; Kossmann et al., 2025; McNulty et al., 2025), an approach currently being trialled in the Netherlands (RESPECTfarms, 2026). Likewise, although restrictions on the term 'meat' for cell-cultured foods are contested by some as a form of 'label censorship' (Gerber et al., 2025; GFI, 2025), these restrictions can be useful to clearly delineate the regulatory framework for cell-cultured foods from that of conventional meats (FAO and WHO, 2023a; FSANZ, 2025a).

Kai (food) plays a central role in te ao Māori, intimately connected to collective and intergenerational knowledge systems. Burgess and Koroi note that 'any conversation about kai is inherently a conversation about whanaungatanga – being in good relation' (Burgess and Koroi,

> Cellular agriculture is at an embryonic stage in the Aotearoa New Zealand food landscape, with active researchers, a small number of start-up companies and a comparatively agile regulator by international standards.

2024). The right for Māori, as the Indigenous people of Aotearoa, to exercise culturally relevant food practices are protected by instruments such as the United Nations Declaration on the Rights of Indigenous Peoples, He Whakaputanga and te Tiriti o Waitangi (Smith and Hutchings, 2025). However, Māori have historically had little influence over the introduction of new food technologies or the commercialisation of local resources (Burgess and Koroi, 2024). The emergence of cellular agriculture offers an opportunity for policymakers to engage in conversations pertaining to kai sovereignty and Māori leadership in this space (Hudson et al., 2019; Macmillan et al., 2025). Early conversations might involve the management of cell lines from taonga species (Smith and Hutchings, 2025), approaching the safety and labelling of cell-cultured products in a Māori-specific context (Macmillan et al., 2025), and the development of terminology and clear labelling in te reo.[8] It is important that these conversations are led by Māori stakeholders and have direct benefits for the Māori economy, recognising the significant role of Māori agribusiness in New Zealand's primary sector (Rout et al., 2024; PWC, 2025).

How can regulators best manage cellular agriculture going forward?

As New Zealand begins to formulate its response to this evolving technology, it has been suggested that two 'interpretative paradigms' can be used to assess existing regulation of cellular agriculture (Johnson and Monaco, 2025). The first assumes that cell-cultured production will scale to be cost-competitive in the short to medium term, beginning to provide significant ethical, environmental and public health benefits within the next five years. Innovation should therefore be enabled through responsive regulation. Efficient approval processes mean companies can begin generating revenue quickly enough to stay viable. Under this paradigm, regulation is mainly necessary to ensure product liability and address potential consumer concerns around the quality and safety of cell-cultured food (Johnson and Monaco, 2025; Manning, 2024). Therefore, regulation should be primarily informed by robust engagement with industry and the repurposing of frameworks from existing industries, then continuously adjusted as more scientific data is collected (Bennie et al., 2025). This paradigm, where the focus is on 'minimum viable regulation', is often encountered in scientific literature and industry reports (Johnson and Monaco, 2025).

The second interpretative paradigm moves beyond a scientific risk assessment approach, placing less tangible social and environmental implications and perspectives forward for regulatory consideration (Johnson and Monaco, 2025). Here, despite the potential benefits of cellular agriculture, policies should not simply advance 'better' innovation. Food safety regulations are seen as necessary but not sufficient for sustainable innovation; it is not guaranteed that short-term biotechnological progress will provide net environmental benefits or ensure equitable access to food (Reinhardt and Monaco, 2025). As a result, evidence-based standards should be developed that encourage companies to direct investment towards socially responsible goals (Manning, 2024; Monaco, 2025b). Within this paradigm, public participation and values-based debates are encouraged, and instead of focusing on specific foods or technologies, the broader future of food is considered.[9] While underexplored in the context of cell-cultured meat, it has been used elsewhere in the literature when considering novel foods and technologies (Johnson and Monaco, 2025). Both paradigms can contribute useful insights when considering the future of cell-cultured food regulation.

Local authorities should therefore emphasise both efficiency and transparency when reviewing legislation in the context of cellular agriculture. This could include considering whether amendments should be made to the Animal Products Act 1999 and the Food Act 2014 to ensure safe cell-cultured food production in New Zealand (FSANZ, 2025a), or whether the existing import health standards for cell cultures (under the Biosecurity Act 1993) are sufficient for cell lines and other cell-cultured ingredients for food use (MPI, 2026). Our response should be informed by developments internationally, ensuring that regulations are harmonised with those of other jurisdictions where possible and appropriate in a local context.[10] There is particular interest from industry in mutual recognition of approvals between jurisdictions to shorten timelines, although establishing mechanisms to do so could come at the cost of valuable local debate (FSANZ, 2025a; Monaco, 2025b). In the first instance, aligning risk assessments with other jurisdictions can help provide direct access to markets for local companies – for example, regulating hybrid cell-cultured pet food production in a manner that simplifies entry to the EU pet food market, or standardising guidelines for cell culture media ingredients.[11]

Conclusion

Cellular agriculture is at an embryonic stage in the Aotearoa New Zealand food landscape, with active researchers, a small number of start-up companies and a comparatively agile regulator by international standards. This sets us up for success as an innovator and exporter of this novel food class. Trusted relationships between researchers, companies and regulators will be key to nurturing success, along with open and transparent communication with the general public and specific interest groups, to avoid the mistakes that have been made in the past around analogous new technologies. The lessons learned from successfully enabling cellular agriculture in Aotearoa New Zealand can inform our approach to managing other emerging food technologies in the future.

1 Cell-cultured meat is variously known as cultured meat, cell-based meat, (cell-)cultivated meat, cellular meat, *in vitro* meat, animal-free meat, slaughter-free meat, clean meat, synthetic meat, artificial meat, vat-grown or lab-grown meat, among other terms (FAO and WHO, 2023a).
2 Similar in appearance to a commercial brewing tank or milk tank at scale.
3 In food safety, a hazard is any 'factor or agent that may lead to undesirable effects', while a risk is the chance that one or more of these 'effects' will occur (Bennie et al., 2025).
4 Cross-reactions between materials during processing may also create new allergenic by-products.
5 Environmental effects investigated in recent LCAs include impacts on soil, water and atmosphere. Additionally, they compare the use of limited resources such as water, land, fossil fuels and energy (Kossmann et al., 2025; Risner et al., 2025; Sinke et al., 2023; Tuomisto et al., 2022).
6 Defined in Standard 1.5.4 as 'a food obtained by culturing cells isolated from any of the following sources: livestock; poultry; game; seafood (including fish); an egg or an embryo of any of the former' (FSANZ, 2025c). By contrast, novel foods are defined as any food with no history of human consumption that requires an assessment to ensure safe consumption (Monaco, 2025b).
7 This is particularly true for processes rapidly undergoing constant innovation during scale-up: these may not match the initial processes documented on application after several months have passed.
8 Translation of cellular agriculture terms is being explored in other jurisdictions using back translation methods (FAO and WHO, 2023a).
9 As Manning notes, 'the application of technology in food production is neither ethically nor morally neutral; rather, it is value-laden as the technology itself shapes future culture and society' (Manning, 2024).
10 If local authorities introduce additional measures that are not present in other jurisdictions, they should be justified under one of the interpretative paradigms discussed.
11 Currently being explored by Singapore and China within the Codex Committee on Food Additives (Codex Committee on Food Additives, 2025).

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