



Research Article

A just transition for cellular dairy? Reflections from the Fraser Valley

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Abstract

Food systems globally are under growing pressure to transition in response to climate change, ecological degradation, shifting consumer expectations, and persistent social inequities. Emerging biotechnologies, including cellular agriculture, are increasingly positioned as part of these transitions, yet their social and political implications remain unclear. This study examines the potential emergence of cellular dairy in British Columbia's Fraser Valley, the centre of the province's dairy industry and a region shaped by intensifying climate risks, entrenched supply management structures, and the colonial dispossession of unceded agricultural lands. Through twenty semi-structured interviews with farmers, processors, policymakers, technology

developers, and members of non-governmental organizations, we analyze how key actors understand the challenges facing conventional dairy, their expectations for cellular dairy, and whether they see it as potentially part of a just transition in agriculture. Participants identified possible environmental and animal welfare benefits but raised concerns about farmer livelihoods, regulatory ambiguity, and the potential for increased corporate consolidation. Their transition imaginaries emphasized stability and the protection of existing food systems structures. Largely absent from participants' discussions of a just transition were the perspectives of Indigenous nations and farmworkers. Using the 5R Framework for Reparative Just Transitions, we interpret

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these omissions as evidence of an understanding of a just transition that overlooks deeper land and labour relations. We argue that a reparative lens helps broaden the scope of transition planning by foregrounding recognition, representation, redistribution, settler

responsibility, and resurgence. Such an approach is needed if debates about cellular dairy are to contribute to more equitable and ecologically grounded food system futures in the Fraser Valley.

Keywords: Agricultural adaptations; cellular agriculture; climate change; dairy systems; just transitions; social implications of emerging technologies

Résumé

Les systèmes alimentaires mondiaux subissent une pression croissante pour opérer une transition face aux changements climatiques, aux perturbations écologiques, à l'évolution des exigences des consommateurs et aux inégalités sociales persistantes. Les biotechnologies émergentes, telles que l'agriculture cellulaire, sont de plus en plus considérées comme un maillon de cette transition. Or, leurs répercussions sociales et politiques demeurent indéterminées. Cette étude se penche sur l'émergence potentielle de la production laitière cellulaire dans la Fraser Valley, centre de l'industrie laitière de la Colombie-Britannique et région marquée par les risques climatiques en augmentation, des structures de gestion de l'offre bien établies et la dépossession coloniale de terres agricoles non cédées. À partir de 20 entretiens semi-structurés avec des agriculteurs, des transformateurs, des décideurs politiques, des concepteurs technologiques et des membres d'organisations non gouvernementales, nous analysons comment les acteurs clés comprennent les défis de l'industrie laitière conventionnelle, quelles sont leurs attentes quant aux produits laitiers cellulaires, et s'ils considèrent que ceux-ci peuvent contribuer à une

transition juste en agriculture. Les participants ont mentionné des bienfaits possibles pour l'environnement et le bien-être animal, mais ont soulevé des préoccupations quant aux moyens de subsistance des agriculteurs, aux ambiguïtés dans la réglementation et au risque de consolidation des grandes entreprises. Leurs scénarios de transition mettaient l'accent sur la stabilité et la protection des structures existantes. Les perspectives autochtones et celles des ouvriers agricoles concernant une transition juste étaient notablement absentes des discussions des participants. En nous appuyant sur les 5R du Cadre pour des transitions justes et réparatrices, nous interprétons ces omissions comme des preuves que cette conception de ce qu'est une transition juste néglige les relations profondes autour du territoire et du travail. Nous affirmons qu'une perspective réparatrice élargira la portée de la transition prévue en mettant de l'avant la reconnaissance, la représentation, la redistribution, la responsabilité coloniale et la résurgence. Cette approche est nécessaire pour que les débats sur l'industrie laitière cellulaire contribuent à de futurs systèmes alimentaires plus équitables et écologiques dans la Fraser Valley.

Introduction

Emerging biotechnologies are reshaping how societies imagine the future of food. Among these, cellular dairy, or the production of milk proteins through microbial or cell-culture processes, has been promoted as a potential response to the environmental and ethical challenges of livestock agriculture. Yet technological transitions do not unfold in a vacuum. They are layered onto histories of land use, labour, and policy that determine who benefits from change and who bears its costs. This paper examines the emergence of cellular dairy in British Columbia's Fraser Valley as a test case for what a just transition in agriculture might entail, addressing not only emissions and efficiency but also the social and ecological legacies that continue to shape the region's food systems.

The Fraser Valley River District (FVRD) is home to over 70% of dairy farms in British Columbia (BC) (MNP LLP, 2020). It is the most intensive agricultural area in BC, generating a larger sum of farm receipts than any other region, and contains some of the most fertile and expensive farmland in Canada (British Columbia Agriculture & Food Climate Action Initiative, 2015; Farm Credit Canada, 2022). However, the region is vulnerable to climate-related risks. In 2021, for example, farmers in the FVRD faced a record-breaking heat dome, catastrophic floods, and extreme freezing temperatures—and some farmers are still recovering (CBC, 2024; Little, 2021; Olsen, 2023). The November 2021 flooding killed at least 428 dairy cows in the FVRD and destroyed shipping routes, forcing farmers in the region to dump 7.5 million litres of raw milk (Kennedy, 2021a, 2021b). While this flood broke records, it was not the first and is unlikely to be the last. Most of FVRD's agricultural land is within the floodplain of the Lower Fraser River, which runs from the mountains in the east to the Pacific Ocean, presenting escalating, seasonal flood risks.

Dairy farming has played a significant role in shaping Canada's agricultural landscape and rural economies since the early stages of European colonization in the 1600s (Barratt & Poulin, 2025). For thousands of years, the area now known as the Sumas Prairie, between the Sumas and Vedder mountains, comprised the large dynamic Semá:th (Sumas) lake and surrounding wetlands in the traditional and ancestral territories of the Sumas First Nation. In the 1920s, the BC Government erected a series of dykes, canals, dams, and pump houses to permanently drain the lake to clear land for agricultural production and settlements (Reimer, 2018; Thielmann, 2022). The Sumas First Nation peoples were forcibly removed from their unceded territory, and the local ecosystem was significantly altered. Following the 2021 flood, discussions on how to manage future flooding in the area are ongoing, with Sumas First Nation advocating for solutions that can see both an increase in ecological health and in their cultural authority within the region (Milne et al., 2024).

These overlapping ecological, economic, and historical tensions have intensified debates about how food systems in the region might adapt to future crises. In this context, technological innovation is often framed as a potential solution to the intertwined challenges facing agriculture today. Cellular agriculture is one such technology, which employs cellular biology to cultivate animal-derived proteins in two main ways: by engineering microorganisms to produce specific proteins through precision fermentation or by growing animal cells directly in bioreactors—offering an alternative to conventional animal agriculture. These technologies may also offer the potential to reduce the negative environmental impacts associated with traditional animal agriculture (Mattick et al., 2015; Tuomisto & Teixeira de Mattos, 2011), depending on supply chain

configurations, energy sources, and process efficiency. Research suggests that cellular agriculture may also be able to improve human health outcomes and food security, while reducing reliance on animals (Soice & Johnston, 2021; Stephens et al., 2018). “Animal-free” dairy has been sold in the US since 2019 and was approved for sale by Health Canada in 2023 (Brehaut, 2024). While no such product has hit the Canadian market to date, Health Canada’s approval may mean that further changes are coming for the Canadian dairy sector.

This paper considers the potential emergence of cellular dairy in Canada through the lens of the just transition. The just transition framework was developed by labour movements to guide the shift toward low-carbon, sustainable futures, ensuring that the benefits and burdens of change are distributed fairly and that vulnerable groups are not left behind. Because the Canadian dairy sector reflects a historical pattern of ownership by wealthy, predominantly white producers, the potential disruptive nature of this technology could provide an opportunity for a just transition in the

Canadian agri-food sector. We designed an interview study to answer the following questions: How do different interested groups in BC’s dairy sector—and the FVRD in particular—perceive the challenges and opportunities for traditional dairy, pathways for cellular dairy, and their potential implications? Could cellular dairy be part of a just transition, and if so, what might it look like? Our discussion applies the “5R Framework” for reparative just transitions (Bowness et al., 2025). This framework critiques various approaches to just transition in settler colonial contexts, assessing the extent to which they: (1) recognize the historical and structural harms of colonial land development; (2) represent marginalized voices; (3) redistribute material benefits; (4) embrace relational settler responsibility, and (5) foreground Indigenous resurgence. Considering cellular dairy in the Fraser Valley through this lens raises questions about whether this technology is positioned to contribute to a just transition in British Columbia’s Fraser Valley.

A just transition for livestock systems?

The just transition became a flashpoint in Canadian politics. In 2021, Natural Resources Canada released a “Discussion Paper” on just transition strategies as a platform for federal government public consultations to inform future policies and programs (Natural Resources Canada, 2021). But progress is slow. The Auditor General of Canada conducted an audit of the just transition process in 2022, finding that “Natural Resources Canada, working with Employment and Social Development Canada and partners on behalf of the federal government, was not prepared for a just

transition to a low-carbon economy” (Office of the Auditor General of Canada Government of Canada, 2022). Then, Alberta Premier Danielle Smith denounced proposed federal Just Transition legislation as an “unconstitutional and existential threat” to Alberta’s oil and gas economy in 2023 (Markusoff, 2023).

The just transition debate in Canada could be viewed as a microcosm for how it has played out on the global stage. Today, the just transition represents a substantial thread in global policy dialogues due to the

need to shift towards a low-carbon economy while balancing environmental imperatives with the protection of those likely to be negatively impacted by transition efforts. As articulated by the International Trade Union Confederation (2015), a just transition entails navigating the transition to a sustainable future in a way that maximizes the benefits of climate action while minimizing hardships for workers and their communities.

However, there is only nascent academic literature on just transition in food systems (Blattner, 2020; Dale, 2025; Ruder et al., 2022; Tribaldos & Kortetmäki, 2022; Verkuil et al., 2023). Blattner (2020) contends that while coal and agriculture generate comparable levels of greenhouse gas emissions, only the former is subject to discontinuation measures. Despite contributing approximately 25 percent of global greenhouse gas emissions (IPCC, 2019), legislative and executive actions addressing emissions from agriculture remains disproportionately sparse compared to those addressing energy (Averchenkova, 2019 p. 22). This disparity highlights the urgent need to align agricultural

policy frameworks with the principles of a just transition, taking into account the broader social and ecological context (Anderson, 2019; FAIRR, 2022; ProVeg International, 2022; Verkuil et al., 2022, 2023).

Should cellular dairy become viable at scale, it could provide a critical test case for extending just transition principles beyond the energy sector into food systems. Although cellular agriculture has the potential to challenge the dairy industry's structural inequalities, many scholars argue that, in practice, it currently risks reinforcing existing power structures. Howard and others note the strong connections between cellular agriculture start-ups and major agribusinesses, suggesting that successful ventures may ultimately entrench the corporate food regime rather than reshape it (Howard, 2022; IPES-FOOD & Howard, 2022). Similarly, Broad and Chiles (2022) argue that cellular agriculture could replicate not only corporate structures but also broader inequitable social relations in the food system, underscoring the need to examine this emerging technology through the lenses of social equity and food justice.

Methods

We explore how key actors in the Fraser Valley Regional District (FVRD) and BC dairy industry view the future of traditional and cellular dairy. Between December 2021 and April 2022, we conducted 20 semi-structured virtual interviews with six farmers, five government officials/policymakers, four NGO representatives, four technology developers, two academic researchers, and two dairy processors. Some participants held more than one role, and one interview involved two participants at the same time. While all farmers were in the FVRD, a

few other participants were from elsewhere in BC or Canada. We recruited participants by emailing local agri-food organizations to share our information with their members and colleagues. While Dairy Farmers of Canada and other Marketing Boards were unwilling to distribute the call, we received assistance from several other groups to include farmers and processors. We reached out to technology developers and government staff directly. We also used “snowball” sampling, where participants provided our information to others they

expected would be interested. All interviews were audio-recorded, transcribed using Otter.ai, and coded in NVivo. The interview guide is provided in Supplemental Information.

The results and discussion in the paper are the product of two complementary analytical approaches. First, we present the findings from inductive thematic analysis, summarizing participant views on the current state of the dairy industry, their perceptions of cellular dairy, and anticipations of possible transitions. To theorize how cellular dairy could be part of a just

transition, we put the results in conversation with the 5R Framework for Reparative Just Transitions: Recognition, Representation, Redistribution, Settler-Responsibility, and Resurgence (Bowness et al., 2025). Reparative just transitions extend beyond mainstream labour-focussed and critical approaches by centering material and relational repair for harms caused by colonialism and capitalist expansion. Its focus on addressing food system inequities in settler-colonial contexts makes it particularly relevant for assessing transition pathways in the Fraser Valley.

Findings

We present the findings from the interviews in three parts: 1) a description of conventional dairy in the Fraser Valley; 2) the possibilities and perils of cellular dairy for this region and beyond; and 3) potential changes to the local dairy industry in response to cellular dairy.

Conventional dairy in the Fraser Valley

In the interviews, the defining characteristics of the conventional dairy sector were its political economic context and associated environmental issues.

Supply management and economic pressures

Across the country, the dairy sector is conditioned by shared political and economic factors. One distinguishing feature of Canadian dairy is its supply management system. Unlike traditional subsidy-based models, which can distort global markets and lead to overproduction, Canada's supply management system relies on a combination of tariffs, quotas, and marketing boards to match supply to anticipated

demand. One farmer explained: “[supply management] takes out the competition between firms, which I fully support” (Participant 3, Farmer). Other farmers agreed, finding it was integral to preserving traditional, albeit less efficient, farming practices which could prioritize animal welfare and environmental stewardship over profitability. However, interviewees acknowledged negative aspects of the system as well. One government employee explained: “the price of milk is higher because of supply chain management [...] that’s worse for poor Canadians and better for dairy farmers.” (Participant 4, Gov). Participants suggested that supply management is related to the concentration of political power within the sector and results in high prices for consumers, but that the system is firmly entrenched.

Even so, neoliberalism may be eroding the strength of the supply management system. Whereas supply management involves regulating production, pricing, and imports to ensure stability and fair returns for domestic dairy producers, trade agreements affect this system by opening markets to foreign dairy products. For example, the Canada-United States-Mexico

Agreement (CUSMA), includes provisions that grant American dairy producers increased access to the Canadian market. Under CUSMA, Canada agreed to expand tariff-rate quotas for dairy products, allowing for greater imports of—often cheaper—American milk, cheese, and other dairy items. This increased competition can pose challenges for local dairy producers: “with each of these agreements, Canada has agreed to open up its market for a certain percentage of the domestic market [...] which does take away some of the potential [for farmers] to increase their herds and their revenue streams” (Participant 7, Gov). In response to trade-agreement-related losses, the Canadian government has agreed to compensate producers and processors, in supply-managed sectors, up to \$4.8 billion CAD (Agriculture and Agri-Food Canada, 2022). Looking ahead, this pressure may intensify. CUSMA is scheduled for a joint review in July 2026, and supply management has been a point of contention in Canada US dairy relations, raising the prospect of renewed pressure for additional market access.

In addition to increased competition from outside producers, dairy farmers must also contend with the rising costs, labour shortages, an aging workforce, and declining demand amidst changing consumer expectations. One farmer expressed frustration about this topic:

Society somehow thinks that cheap and plentiful food is an inherent right. Yeah, and somehow, we’re [farmers] supposed to accommodate all that. You know, treat our animals ethically, take good care of the land, keep it green and beautiful, make it very appealing to everybody. But ‘You want to actually earn some money? Hold on just a sec– we don’t like that part.’ (Participant 8, Farmer/Gov)

Dairy farmers as stewards of changing environments

Dairy farmers are dealing with increasingly challenging environmental conditions. Respondents, in 2022, reflected on the devastating impacts of extreme weather the year before:

We had a ‘heat dome’ in the summer, and then we had a pretty prolonged kind of freezing ‘winter freeze’ that had some negative effects, and in between we had one of the worst floods in the history of modern farming in the area. (Participant 2, Farmer)

These extreme events left lasting impacts on the farmers and farmworkers, as well as the cows who survived. There are also concerns about the likelihood of more extreme weather events in the future. Even in the face of natural disasters, such as the intense flooding in 2021, one participant recounted how Fraser Valley farmers risked their own safety for their animals: “As we saw in the floods, [farmers] are obviously caring for their animals, and even swimming through toxic waters to save their animals. [...] I spend more time with these animals than I do my friends” (Participant 3, Farmer). Dairy farmers view themselves as stewards or caretakers of the land and animals. As another farmer noted with pride, “despite these challenges, it’s something I wouldn’t change for anything [...] my passion is the animals” (Participant 8, Farmer/Gov).

However, participants recognized that not all farmers have this type of relationship with their animals: “there’s a lot of things that we, as an industry, could certainly improve on and should not ignore” (Participant 8, Farmer/Gov). Animal rights activists call attention to the harmful living conditions of dairy cows, such as forced separation from their calves, although the dairy representatives feel that some of the critiques are unwarranted:

The industry has been under attack from so many angles. One that they've become so sensitive to is the unfair attacks by animal activists, I call them extremists. [...For the extremists], it's about eliminating animal agriculture. (Participant 7, Gov)

The dairy sector also faces critique for its ecological “hoofprint” (Weis, 2013). Conventional dairy is resource-intensive and releases large amounts of greenhouse gases (especially methane) into the atmosphere, as well as other pollutants into the surrounding ecosystems. An NGO organizer noted:

Cows are a very large source of methane in Canada, and dairy is a big part of that. [...] But then there's land and water use, water contamination, topsoil erosion, you name it. [...] It doesn't make a lot of ecological sense. (Participant 9, NGO)

These pressing ecological challenges raise the question of whether cellular dairy could help reduce land and resource pressures by shifting production away from conventional livestock.

Possibilities and perils of cellular dairy

The interviews elicited a wide range of responses to the potential of cellular dairy in the Fraser Valley, with all participants simultaneously holding both positive and negative views of the technology. Interestingly, despite the controversial nature of the technology, interviewees often focused more on the potential benefits and opportunities than the risks and concerns. Farmers were the least optimistic about the potential benefits of cellular dairy but remained open-minded.

Opportunities: Climate and animal welfare

Advocates of cellular dairy promote the technology's potential to mitigate environmental challenges associated with conventional dairy production. An

academic pointed to how cellular dairy “could be a more efficient process to produce milk, so you reduce the number of cows and the greenhouse gas emissions they produce, also perhaps the amount of land” (Participant 16, Academic). By cultivating dairy proteins in controlled environments, cellular dairy production can theoretically reduce land and water requirements, minimize methane emissions from livestock, and alleviate pressure on ecosystems threatened by agricultural expansion.

Others, including a technology developer, pointed out that localizing food production, by building cellular agriculture facilities near dense population centres, could reduce carbon emissions associated with the transportation of dairy products: “If we were to have a technology that could be located in every city or big cities, then we can have easier access to milk without having to ship it and having a bigger environmental footprint” (Participant 14, Developer).

The interviewees also thought cellular agriculture could have significant implications for animal welfare. At its core, this technology is positioned to produce meat and animal products directly from cells, without the need slaughter animals. This applies to the dairy cows themselves, and their calves, as described by one NGO representative:

The day-to-day for a dairy cow is a life of boredom and frustration and pain. [...]. But there's also what happens to the calves that are born in the industry. To produce milk, you need calves being born. And that in turn translates into other industries like the veal industry [...]. This [cellular dairy] is a solution that poses a historic opportunity to bring that suffering to an end. (Participant 9, NGO)

Decreasing animal suffering is a motivation for some cellular agriculture developers, including one that we interviewed:

We are able to make the same milk without the animal, so the animal is not necessary in this process. So, we want to remove the focus from the animals and stop breeding them for a food purpose. For me, it's all about animal welfare. (Participant 14, Developer)

One participant acknowledged the “animal welfare concerns—overbred cows, hyper-productive milking machines, calf-cow separation issues” and commented that farmers often take issue with this characterization of their farmers:

You see it more and more in the media, that farmers give kind of a counter push against that, instead of exploiting their animals, they're saying, 'No, we do take good care of them. And they can roam freely, and they can be milked whenever they want.' (Participant 16, Academic)

Overall, farmers did not view cellular agriculture as a solution to animal welfare concerns in the sector, reinforcing their perceptions as stewards who take good care of their cows, although many participants agreed that cellular dairy could offer benefits for the environment and animal welfare.

Concerns: Farmer livelihoods, competition, and accessibility

Nearly all participants held a shared understanding that the cellular agriculture transition could be highly disruptive. Both government representatives and cellular agriculture developers were specifically concerned about the farmers: “I don't want them [farmers] to lose their livelihoods. I think there should be systems put in place to transition farmers from dairy farming to a kind of technology like this” (Participant 14, Developer). Beyond dairy farmers, one developer noted that technological development more broadly presents labour concerns across many sectors.

Another common concern can be distilled to a philosophical debate over what counts as “agriculture” or “dairy.” Several interviewees questioned the use of the term “milk” to describe cellular dairy, which echoes questions about whether plant-based milk alternatives should be called “milk.” Whether cellular dairy is deemed “agriculture” or “dairy” by regulators has specific implications for farmer incomes and where production can take place. This farmer went on to question where cellular agriculture production could be based given the agricultural land zoning in BC: “Does that [cellular agriculture] belong in ag[riculturally zoned] land? I don't believe it does” (Participant 8, Farmer/Gov). The supply management system and dairy quotas present additional political and economic complications if cellular dairy is produced and sold in Canada. If cellular dairy can be called “milk,” farmers were also concerned that it could detract from the value they create in building a reputation for producing quality dairy products.

Many interviewees had concerns about the political economy of cellular agriculture. One developer noted that tech start-ups are the driving force of the industry, which influences who benefits most from the development and commercialization of cellular agriculture: “I worry about the wrong people getting the money” (Participant 19, Developer). An NGO representative cautioned that there are risks to food system resilience:

We have an industry that, by definition, has to be centralized because of the massive investment that's required to scale. And with that, you're going to see the big protein companies around the world owning the technologies, setting up a centralized distribution model, which we know having come through the pandemic, does not really support food security in a way that we want it to. (Participant 9, NGO)

Another NGO representative also noted that the highly privatized nature of technology development firms can limit who will be able to access the technology:

One of my biggest concerns is the accessibility of this technology. And I think in general in so far, we're seeing that a lot of investment is really private, and a lot of that knowledge is not being shared. (Participant 20, NGO)

A third NGO representative drew attention to the potential equity concerns related to the cost of cellular dairy products: "I would never want people to think that, if they can't [afford] this cellular agriculture product, then they shouldn't consume milk or dairy products at all; so food affordability would be a big concern in understanding how the average Canadian can access this product" (Participant 10, NGO).

Potential dairy transitions

The transition won't happen in one week. It will happen over time. And, for us, it's important to support everyone [including farmers]. (Participant 14, Developer)

...if we were to only look at the benefits of cell ag, we would be remiss, and we wouldn't be doing our jobs well. [...] We have to do it in collaboration with food producers right now. (Participant 9, NGO)

...if you don't want to be forced into a new occupation, chances are you do what everybody does in a transition: You, you pivot and you, you make it work with what you're interested in. (Participant 3, Farmer)

In the context of the BC dairy sector's status quo and the anticipated challenges and opportunities for cellular dairy, we explore three potential transition scenarios.

Cellular dairy fizzles out

Participants did not think uptake of cellular dairy in BC was inevitable. Regulation, industry opposition,

consumer acceptance, economic stability, and technological development are the matters of most concern.

Cellular dairy is still pre-commercial, which means there are several substantial hurdles it must overcome if it is going to assume some of the existing dairy market share. One developer pointed to subsidies and government support for conventional dairy as an obstacle for cellular dairy:

Bovine dairy is a highly subsidized commodity. And in order for cellular agriculture to even approach price parity with milk, that's from a technical standpoint, I can tell you as a biologist that's going to be a very, very tall ask. (Participant 19, Developer)

Another issue relates to regulatory frameworks and uncertainty associated with new technologies and products entering the market: "The regulatory path is not clear, and there are a number of [...] adjacent regulatory issues that need to come up, like how do you regulate a kind of facility that doesn't exist yet in this country?" (Participant 9, NGO).

While there are already some precision fermentation products on the market in Canada, none of these products claim to be "dairy," while cellular dairy may make claims to this term. In the US, Perfect Day refers to its products as "animal-free dairy," which may cause substantial challenges in the context of supply management's impact on Canadian products.

Some participants expected insufficient consumer acceptance to squash cellular dairy transitions. While existing data on peoples' willingness to consume suggests there are reasons to believe that cellular dairy will be accepted by consumers if it reaches price and quality parity, there is the possibility that consumers may succumb to the "ick factor," or fears about the novelty of cellular agriculture products: "I think that's one of the biggest challenges, is a new phobia, the fear

of the foods, and ‘robot’ or ‘alien foods’” (Participant 14, Developer). While the “ick factor” remains a prevalent concept in cultured meat discourse, its actual influence on consumer acceptance remains contested. Based on interviews with 19 taste testing event attendees, Gerber et al. (2025) suggest that allowing consumers to cook cultured products themselves may increase acceptance (p. 5), potentially attenuating the perceived impact of the ick factor. Hamlin et al. (2022) similarly argue that a food neophobia scale, which measures an individual’s aversion to unfamiliar or novel foods, fails to capture the attitudes and emotions that shape responses to novel foods, proposing instead that attention to specific cultural values may better indicate alignment between such products and consumer identities (p. 3). Debate around the role of this “ick factor” is therefore likely to remain largely speculative until cellular dairy products are introduced to the market at greater scale.

Cellular dairy fully displaces conventional dairy

While perceived as an unlikely outcome, a few participants considered the possibility that cellular dairy could fully replace conventional systems. Developers, as well as government and NGO representatives, acknowledged the potential disruptions the cellular dairy may cause, drawing parallels to past instances of technological upheaval in other industries. An NGO representative notes:

It might be something similar to [...] Uber, when they came in. Because they also are kind of in a quota system where they have to buy these licenses and they spend a lot of money, and then if the competition comes in that disrupts the market, then their investment is worth nothing. (Participant 6, NGO)

Similarly, the realization of cellular agriculture’s potential could impose significant challenges for the dairy industry, prompting concerns about the livelihoods and historical investments of those involved. One government official acknowledged the complexities of managing such transitions:

I think one is sympathetic to supporting farmers and supporting families through transitions. We don’t always do that, though. [...] If you think of how Uber upended the medallion system for taxi drivers, we didn’t support that supply-managed system through any kind of transition. (Participant 4, Gov)

Participants recognized that this transition would result in stranded assets, or infrastructure from the conventional dairy system that would no longer be usable in a new cellular dairy economy:

Over time, you won’t have to have all of that infrastructure around cows. So, all of the things that include feeding, the slaughterhouses, the farms, the dairy farmers, all of that has to be taken care of through the production of milk. [...] You diminish the number of people interacting in this process. (Participant 14, Developer)

Supply management is set up to account for fluctuations in consumer demand or external influences on supply, as with trade agreements—when demand drops, prices rise and farmers are compensated. A managed decline in demand, caused by a corresponding increase in demand for cellular dairy, could be balanced through the quota system. Another option would be to “buy out” some of the dairy farms:

The average farm owns maybe 2.6 or 2.7 million dollars in quota. [...]. So, they’ll either issue new quota and they’ll actually sell to some people in the industry already or they’ll buy some people out. [...] When you make milk, the money you get from processors by law will cover all your costs, whether you dump your milk or not, you’re guaranteed to

make money at the end of the year. (Participant 1, Academic)

Another NGO organizer noted that this transition would likely need to follow a slow process of phasing in new products and phasing out existing farming operations, which would need to consider the impact on the animals in the current dairy system. They compared the transition to the slow entry and growing presence of dairy alternatives on the market:

I guess best case scenario would be to have it slowly phased in as a separate alternative to start with. So, have it come in kind of like almond milk or oat milk. [...] You're not going to get rid of conventional milk entirely, there's always going to be some market that wants that [...] giving dairy farmers the opportunity [...] to become involved in [cellular dairy] production so that they're able to maintain an income (Participant 5, NGO)

Cellular and conventional as complementary protein systems

Most participants believed that a most likely scenario is that the diffusion of cellular dairy in Canada results in two separate and potentially complementary systems. A dairy processor stated, “it’s not about substituting one for the other, it’s about finding place for both, eventually,” while maintaining that the change will “come at a cost” (Participant 18, Dairy processor). Another dairy processor felt that there would always be a market for the “feel-good” aspects of traditional dairy:

As an organic public-facing farmer, it’s a little bit easier because we have that connection with our consumers already [...]. I don’t think that would change with the addition of cellular agriculture on the market. (Participant 12, Dairy processor)

Some participants suggested that the coexistence of cellular and conventional dairy could enhance the

sector’s resilience and sustainability. Given the increasing preoccupation with health risks in the food system, one developer noted that bringing bioreactor facilities onto farms could ostensibly make dairy less vulnerable to contamination: “bioreactor facilities are sterile in nature so the contamination risk is reduced” (Participant 17, Developer). Another possible benefit from the coexistence scenario could be to aid in the succession of dairy operations, attracting younger and new farmers, based on the assumption that they are more “interested in technology” (Participant 15, NGO).

However, the transition to cellular dairy is not possible without appropriate policy and supports for farmer experimentation and training. For example, an NGO representative explained:

We cannot have a focus solely on the technology itself because it doesn’t matter if we are able to develop and scale it up if we don’t have the policies in place, or we don’t have a process for implementing the technology. (Participant 20, NGO)

Another NGO participant suggested rethinking agricultural subsidies and allocations of “climate money” to incentivize adoption of cellular dairy and “make that transition possible” (Participant 9, NGO). They also suggest that policy support for farmers should include “retraining initiatives” and the potential to license cellular dairy technologies (Participant 9, NGO). A developer similarly suggested “licensing these [cellular agriculture] technologies to dairy farmers so that they can continue to milk, just without cows anymore” (Participant 14, Developer).

Technology developers also noted that more needs to be done to ensure that farmers are involved in discussions about the direction of the technology. In addition to developers offering farmers “training [for] a

very different skillset,” developers can learn from farmers:

There’s a lot of opportunity for harnessing the relevant subject matter knowledge from those communities and bringing it into these applications. And I would love to see more companies in our area doing more to work with the agricultural sector to figure out how to make this transition. (Participant 19, Developer)

One farmer thought that collaboration between conventional and cellular dairy could have benefits:

I like this idea of trying to include the farmer as part of a solution. Again, I’m not sure how you go about that, [... as] there’s a whole quandary of challenges, like land use policy and government, to get the farmer on board. (Participant 2, Farmer)

Nonetheless, most interviewees expected farmers to be resistant to participating in cellular dairy production.

Discussion

I think with justice, it’s also often about, like, trade-offs. Can you have it all? Can you have all kinds of injustices addressed? Will there never be somebody losing out? (Participant 16, Academic)

The interviews illuminate how participants in the Fraser Valley dairy sector understand both the pressures they face and the possibility of technological change. Farmers, processors, government staff, and NGOs described a sector shaped by rising costs, labour shortages, climate disruptions, and shifting consumer expectations. Many emphasized the stabilizing role of supply management and the importance of protecting existing livelihoods as conditions become more volatile. Across groups, participants positioned themselves as stewards of land and animals and expressed pride in

For example, a farmer expressed that adopting cellular dairy would be a step away from what they see as “farming” or “being a farmer” and their passion:

Being in a production facility isn’t really the passion of a lot of farmers. [They like] being outside [with] their animals and being in barns and feeding animals. And I don’t know, if that’s the transition that needs to happen [cellular agriculture], based on the survival of this planet, then yeah, I could see myself doing that. But I wouldn’t be the first one to do it. (Participant 3, Farmer)

An NGO participant expressed a similar evaluation: “the majority of dairy farmers have been dairy farmers for their entire lives; they’re not about to train to be a lawyer at this stage in their careers” (Participant 10, NGO). Collaboration between conventional and cellular dairy may require that farmers be willing to shift their production systems to adopt cellular technology.

their care practices, even as they recognized uneven standards across the industry. Views on cellular dairy were mixed but generally cautious. Participants saw potential for environmental and welfare benefits but also raised concerns about regulatory ambiguity, market acceptance, loss of farmer income, and the capacity of small producers to adapt to disruptive technologies.

These perspectives reflect the vantage points of those working within formal dairy institutions. When asked about cellular dairy, participants drew on their own experiences of environmental challenges, sectoral policy, and day-to-day farm realities. Their visions of transition tended to centre stability, incremental adaptation, and maintaining the viability of existing family farms. Even those who were open to cellular

dairy framed transition primarily in terms of managing risks to producers and ensuring that new technologies do not undermine sector cohesion. Taken together, these findings show that current transition imaginaries in the Fraser Valley are shaped by a desire to preserve core features of the existing system while responding to mounting pressures from climate change, markets, and public scrutiny.

What is notably absent from these narratives are perspectives from those who relate to the dairy system in fundamentally different ways. The interview sample did not include Indigenous peoples whose territories structure the geography of dairy production, nor farmworkers whose labour sustains the industry. Participants themselves largely did not raise these perspectives when discussing future transitions. This absence is analytically important not because participants failed to mention them, but because it reflects the limited set of actors who are conventionally recognized as stakeholders in agricultural change. Transition is thus imagined through the lens of those who hold land, quota, and institutional authority, rather than those whose relationships to land and labour fall outside the boundaries of formal sector governance. These omissions matter because they shape what kinds of transition are thinkable. Without Indigenous or worker perspectives, participants tended to define justice primarily through economic protection for current producers, rather than through broader questions of land access, ecological restoration, or labour conditions. The history of the drained Semá:th Lake or the reliance on precarious migrant labour did not surface in interviews, not because they are irrelevant, but because they sit outside the experiences and responsibilities of those positioned to speak. Recognizing these gaps helps clarify why a narrow, producer-centred understanding of “just transition” may be insufficient for addressing the deeper land and

labour relations that structure the Fraser Valley dairy system.

The 5R framework for reparative just transitions (Bowness et al., 2025) offers a way to interpret these findings and understand what is needed for more expansive transition imaginaries to emerge.

Recognition requires situating present-day vulnerabilities within the longer histories of land transformation that shape the region, yet interview participants understood flooding and climate risks as immediate environmental problems rather than as outcomes of the draining of Semá:th Lake or other colonial interventions that produced the agricultural landscape on which they depend. **Representation** concerns who is positioned to participate in shaping transition pathways, and the interviews reflected only those actors already recognized within formal dairy governance: farmers, processors, government, technology developers, and NGOs. Missing were Indigenous nations whose territories underlie the dairy economy and farmworkers whose labour sustains it, highlighting how existing governance structures narrow whose interests and relationships to land and labour enter discussions about future change. **Redistribution** raises questions about how benefits and burdens are allocated, yet interviewees focussed primarily on safeguarding the economic stability of current producers and did not consider redistribution of land, authority, or technological benefits to groups historically excluded from the sector. **Responsibility** was expressed in terms of environmental stewardship and animal care, but not in relation to repairing deeper harms connected to land dispossession, hydrological engineering, or precarious labour conditions, which suggests that accountability is currently understood within farm-level rather than structural terms. Finally, **resurgence** invites attention to Indigenous-led visions for ecological restoration and governance. As described

in the introduction to this paper, Sumas First Nation is working to restore ecological health and strengthen cultural authority in regional flood-management planning, yet these forms of leadership did not appear in participants' accounts of the future of dairy or cellular agriculture. Together, these patterns show that while participants identified real pressures and uncertainties facing the dairy sector, their visions of a just transition remain oriented toward protecting the existing system rather than addressing the broader land and labour relations that shape agricultural futures in the Fraser Valley.

Conclusions, limitations, and future directions

This study examined how stakeholders in British Columbia's dairy sector understand cellular dairy and whether they see it as part of a just transition. The findings show that while participants recognize profound environmental, economic, and technological pressures facing the Fraser Valley, their visions for change remain shaped by existing relationships to land, production, and consumption. Even when participants imagined significant technological shifts, most framed transitions in ways that protected the priorities of established actors or responded primarily to concerns within the formal dairy system. Applying the 5R Framework for Reparative Just Transitions helped clarify how these narratives attend to immediate risks yet leave unaddressed the deeper land and labour relations that shape the region's food system.

This analysis is necessarily limited by the absence of perspectives from those most affected by these deeper relations, including Indigenous nations whose territories structure dairy production and the farmworkers whose labour sustains it. Their exclusion

Although participants diverged in their hopes for the future of dairy, their visions were all framed within the dominant land and consumption relations that structure food production in the Fraser Valley. Some imagined improving the current system, others replacing parts of it with new technologies, but none articulated changes that would fundamentally alter how land is governed, how labour is valued, or how consumption shapes agricultural priorities. A reparative just transition, by contrast, asks how these deeper relations might be reconfigured.

reflects both recruitment challenges and the early stage of cellular dairy development, but it also underscores structural dynamics that determine who is positioned to comment on agricultural futures. Future research must be grounded in collaboration with these groups, not only to understand their views on emerging biotechnologies, but to identify what forms of transition would genuinely support their wellbeing, authority, and ecological relationships.

Looking ahead, research on cellular agriculture should attend to more than technological feasibility or market acceptance. Neglecting social input in technological development risks deepening the disconnect between innovation and those most directly affected by it (Rao et al., 2023). Scholarship and policy work should therefore consider how governance, investment, and regulatory decisions can distribute risks and benefits more equitably; how transition planning might respect Indigenous sovereignty and strengthen ecological restoration; and how improved labour protections and worker representation could shape

emerging production systems. Integrating these perspectives would help ensure that cellular dairy, if it develops further in Canada, does not simply reproduce the inequities of the current food system.

While the future of cellular dairy remains uncertain, a reparative lens highlights that questions of justice cannot be resolved by technology alone. They depend

on how transitions are imagined, who participates in shaping them, and what responsibilities are acknowledged. If attention is paid to these relational and historical dimensions, debates about cellular dairy can be situated within a broader conversation about what forms of transition are needed to address longstanding inequities in the region's food system.

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