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A Just Transition for Aotearoa New Zealand's Dairy Sector

Abstract

Aotearoa New Zealand has a strong history, culture and political economy of dairy agriculture, all of which are deeply interconnected in the global production and trade of dairy. However, changes in the environment, markets and regulations, and the development of alternative proteins, are disrupting traditional pastoral practices, leading to uncertain food futures. This article draws on insights gleaned over a three-year doctoral project investigating just and sustainable transitions for the nation's dairy sector. The article puts forward three key considerations to shape future policy design principles and guidelines for more just and sustainable dairy futures: navigating intensification pressures; supporting the development of alternative proteins; and supporting farmer agency in the transition process.

Keywords dairy, agriculture, sustainability, just transitions, precision fermentation

Milena Bojovic recently completed her PhD in geography and planning at Macquarie University, Sydney. Her research investigated just and sustainable transitions for Aotearoa New Zealand's dairy sector.

Aotearoa New Zealand's dairy sector remains a competitive producer and leader in global dairy exports (OECD and FAO, 2023). The industry, however, faces increasing pressure from an array of market forces and government regulations, as well as environmental concerns, especially in terms of reducing greenhouse gas emissions such as methane (gas produced through the belching and manure from cattle). In addition to environmental concerns, the social, economic and welfare impacts of intensive dairying across Aotearoa have been well documented (for examples, see Jay, 2008; Foote, Joy and Death, 2015; Julian et al., 2017; Ledgard et al., 2020). These concerns and impacts are situated within the broader challenges facing the global dairy sector, which include scrutiny to meet climate, environmental and welfare goals to ensure sustainable trajectories for future food production (see Bojovic and McGregor, 2022).

Already, major customers of brand Aotearoa's dairy are reorienting supply chains to meet global sustainability agendas. For example, Nestlé has announced exclusive support for farmers engaged in 'planting trees or transitioning to silvopasture systems, introducing multispecies pastures, rotational or mob grazing, collecting and storing manure, and adopting more renewable sources of energy' (Nestlé, 2023). Achieving sustainability is a global challenge, particularly as it pertains to the production of food at scale. This was highlighted at the most recent Conference of the Parties meeting (COP28) in 2023, where the final communiqué stated: 'any path to fully achieving the long-term goals of the Paris Agreement must include agriculture and food systems' (COP28, 2023). Moving towards more sustainable modes of production that address global climate change agendas requires change across multiple scales, both culturally and materially in terms of adopting new dietary patterns and transforming established land, labour and trade configurations to accommodate new food production regimes. Such regimes include recent investment in and development of alternative proteins. Most notably, these include plant-based alternatives such as growing oats for oat milk (see Otis Oat Milk, 2024), and more recent investments in the research and development of precision fermentation. Precision fermentation in the dairy sector, colloquially referred to as 'synthetic milk' or 'lab-grown milk' (Bojovic, 2022) is where the natural process of fermentation is advanced through biotechnology to 'teach the microorganisms to produce dairy proteins' (Vivici, 2024).

This article provides insights and guidance towards just and sustainable transitions for the future of Aotearoa's dairy sector. A just transitions framework is commonly understood in the context of transitions towards low-carbon economies that are more economically, socially and environmentally sustainable as societies move away from fossil fuel energy (Heffron and McCauley, 2018; UNEP, 2007). To provide guidance, this article synthesises key findings from a three-year doctoral study investigating the future of Aotearoa's dairy sector. First, it explains challenges facing the industry from environmental and market pressures. The next section provides context for a just transition aligning with the *Guide to Just Transitions* recently developed by the Ministry of Business, Innovation and Employment and independent researchers and practitioners (Just Transitions Aotearoa Group, 2023) and the emerging scholarship on just food transitions. Following this, key findings from the three-year study are summarised, and three high-level considerations for future policy development in this area are put forward – redressing intensification, support for alternative protein development and support for farmer agency. The conclusion sets out more concrete recommendations for specific government agencies to create openings for further engagement across rural communities, with the vision that such communities could lead transitions planning and processes to support the development of fair policies for the future of dairy in Aotearoa.

Challenges facing the dairy industry

Environmental pressures

Emissions and fresh water are critical topics to discuss within the sustainability discourses of the nation's dairy sector, especially in the context of policy and legislative efforts to meet a net zero target by 2050[1] (Ministry for Environment, 2024a). In Aotearoa, there are inherent tensions between the economic interests of government, industry and farming communities, and ensuring long-term environmental sustainability. Public and political pressure is growing for the dairy industry to improve its environmental footprint. Attempts to address these concerns have manifested in different regulatory approaches that continue to evolve as each successive political administration faces pushback from opposition politicians, industry, and advocates for dairy farming communities.

According to a recent survey by Crown research institute Manaaki Whenua Land care Research, fresh water was considered the most important issue facing Aotearoa from 2010 to 2019, and from 2022 more respondents considered climate change to be the most important issue facing the nation (Booth et al., 2022). A variety of stakeholders within and outside the dairy sector are affected by changes to dairy production regimes. These include (but are not limited to) the private sector (primary producers, landholders), rural communities, iwi and policymakers (Norton et al., 2020). Agriculture in Aotearoa contributes over half of the nation's greenhouse gas emissions, mainly through biogenic methane (from livestock) and nitrous oxide (from fertiliser run-off) (Ministry for the Environment, 2024b). Due to this, Aotearoa has a unique emissions profile compared to other OECD nations, with more than half of gross emissions coming from agriculture (OECD, 2022). These high emissions can be attributed to high dairy productivity, as Aotearoa exports 95% of its dairy to 130 countries around the world, with only 5% used for domestic consumption (Dairy Companies Association of New Zealand, 2023).

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environmental and political challenge, due to factors such as widespread irrigation infrastructure for maintaining consistent pasture growth. This increase in groundwater use for irrigation in addition to fertilisers for growth has reduced flows in streams and rivers, as well as increasing nutrient discharges and eutrophication of wetlands (Norton et al., 2020). Government reports have found that between 2002 and 2019, there was a significant – 200% – increase in irrigated land areas, predominantly on dairy farms and particularly in the Canterbury region of the South Island (Statistics New Zealand, 2021).

Market disruptions

Future growth of the nation's dairy sector is expected to be driven by a shift towards higher-value dairy products, which includes new product development, improved efficiency of processing and increased sustainability in milk production (Treasury, 2023). This is because the growth in milk production has slowed since 2015, due to a gradual decline in cattle numbers and tighter environmental regulations (ibid.). Regulations and incentives are coming from industry too, with Fonterra, the nation's largest dairy cooperative and processor of raw milk, recently announcing support for farmers to achieve a 30% intensity reduction in on-farm emissions by 2030 (Fonterra, 2023a). These initiatives reflect global trends from major customers of Aotearoa dairy such as Nestlé, who will pay farmers more to produce low-emissions milk (Fonterra, 2023b).

Alternative proteins provide novel ways to produce protein that requires much less land and fewer animals, emissions, farmers or farms. New areas of research, investment, and production are developing to increase the viability and cost parity of novel protein innovations. They aim to address the sustainability issues associated with traditional dairy farming while ensuring that the food system and human diet continue to have nutritionally equivalent dairy proteins. This has attracted the attention of governments, private investment and entrepreneur innovation (Day et al., 2022). A recent white paper by the Crown research institute AgResearch claimed that, 'radical new processes are needed to meet consumer expectations for less waste, reduced pollution and cleaner, healthier environments', citing the development of animal-free proteins as a opportunities to address this (ibid., p.7).

The production of precision fermentation dairy proteins navigates the challenges of monoculture crops for plant milks while also avoiding the bodily burdens placed on farmed animals. In Aotearoa, there is significant potential for better environmental and animal welfare outcomes through upscaling dairy alternatives. The work of precision fermentation start-up Daisy Lab has continued to expand and it is currently seeking $20 million in investment capital (Wannan, 2024). Their work has been supported through approvals from the Environmental Protection Authority to scale up its lab-grown proteins 500-fold from its existing allowance (Steele, 2024). Meanwhile, in a recent report commissioned by domestic company Boring Oat Milk, oat milk is considered the highest-value land use for plant-milk production in Aotearoa. The report found that a research and policy infrastructure is emerging in Aotearoa that favours advanced arable systems through supportive Crown research organisations oriented towards achieving environmental sustainability (Agribusiness Group, 2022).

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However, alternative proteins come at both economic and social costs. Economically, enduring challenges for the upscaling of alternative proteins include larger food processors competing on price, placing downward pressure on smaller-scale alternative dairy producers (Campbell et al., 2022). Further to this, insufficient investments on-farm and collaboration to optimise these emerging industries for national benefit remain pertinent barriers (Agribusiness Group, 2022). Most importantly, where incumbent farmers fit in these alternative dairy futures is yet to be fully understood. This is where a just transitions framework is much needed.

Defining just transitions

A just transition is increasingly featured in policy discourses, particularly in the context of international climate negotiations and through the advocacy of global union organisations (Krawchenko and Gordon, 2021). Within these discourses, the aim is to support initiatives, mechanisms and practices that can steer society towards low-carbon futures underpinned by attention to issues of justice and equity (Newell and Mulvaney, 2013). However, as Bennett et al. (2019) observe, when economic efficiency or environmental conservation are the overarching policy goals, issues related to the distribution of benefits may be considered less important in planning and decision making. Modifications in established socioecological systems will require shifts in societal assumptions, beliefs and values, as well as in government regimes, development paradigms and power relations. Therefore, transitions need to be carefully planned and managed in ways that can reduce the likelihood of entrenching existing inequalities or creating new ones (Ellis, 2021).

Just Transitions in Aotearoa

In Aotearoa, *A Guide to Just Transitions* (Just Transitions Aotearoa Group, 2023) was recently published by independent researchers and practitioners and the Ministry of Business, Innovation and Employment. The guide maps out general principles to equip communities 'to develop positive visions for change, transform unfair systems, draw on diverse strengths and worldviews, and come together to

solve problems in ways that work better for everyone' (p.1). The guide focuses on four key steps to initiating and achieving a just transition across communities: connecting and building relationships; planning and designing transition processes; acting on collective decisions; and adapting, monitoring and evaluating progress. Key principles for a just transition in this context include meaningful engagement with Māori world views, emphasising the importance of relationships between nature and people, and drawing on values such as 'consensus building, respect, care, balance, intergenerational equity and relationship building', to support 'representation, collaboration, partnership, co-design and participatory democracy' (ibid., pp.16, 12). To this end, the mapping of relevant connections, responsibilities and obligations across all actors can inform understanding about various chains, production networks, and global exchange and divisions of labour (Stevis and Felli, 2020). Consultation processes must therefore be transparent, and outcomes clearly reported upon, as well as both industry and government kept accountable for policy and decision making.

The Ministry of Business, Innovation and Employment (2023) put forward a series of case studies to showcase just transition principles in practice. While dairy agriculture is not a focus, there are some agriculture-adjacent and government-supported initiatives, such as Southland Just Transition (2023), which promotes research on the primary sector's role in Southland's long-term shift to more sustainable production. Regarding just transitions that may directly affect the dairy sector, efforts are being made to support low-emission plant-based beverage manufacturing for future planning (Beyond 2025 Southland, 2023). These efforts underscore the increasing acceptance of just transitions on local and national scales. A recent report by the Parliamentary Commissioner for the Environment investigating agriculture and land use change argued for an integrated approach to environmental management that focuses on the catchment rather than one-size-fits-all national regulation (Parliamentary Commissioner for the Environment, 2024). Achieving this approach will require more detailed case studies of agri-food transitions to address justice issues for those most affected by transitions.

The field of just food transitions

Just food transitions scholarship (see Tribaldos and Kortetmäki, 2022) aims to critically engage with social and environmental sustainability to encompass the complexity of justice issues, including indigenous land rights, economic and social justice, environmental justice, and justice for non-human others, specifically in agricultural contexts. In more practical terms, the study of agricultural transitions offers guidance and principles for understanding and governing long-term processes of structural systemic change (Tschersich and Kok, 2022): for example, studies of agricultural transitions in Finland (Lehtonen, Huan-Niemi and Niemi, 2022; Kuhmonen and Siltaoja, 2022), work on narratives analysis of agricultural transitions in Brazil (Maluf et al., 2022), and work on agroecological transitions for family farms in Guatemala (Valverde, Mesías and Peris-Blanes, 2022). These studies are collated in a special issue of the journal *Environmental Innovation and Societal Transitions* on 'Just food system transition in the context of climate change: tackling inequalities for sustainability' (Kaljonen et al., 2023). With regard to just agri-food transitions, Tschersich and Kok (2022) argue for a pluralising of knowledge, adopting post-growth strategies for economic development and moving towards greater understanding of human–nature relations to support environmental sustainability. Applying this to the pursuit of low-carbon development is also explored by a study of just transitions towards a bioeconomy in Brazil, India and Indonesia, where Bastos Lima argues that a key challenge for a just transition is the reconciliation of 'sustainable agriculture and land use with the imperative of fossil-resource substitution' (Bastos Lima, 2022, p.1). These studies show the value and importance of applying a social justice lens to avoid placeless or 'even more technocratic' (Stevis, 2023, p.50) theories of change that lack empirical engagement. Context-specific and place-based studies are a key feature of just food transitions planning and process. The case of just transitions for Aotearoa's dairy sector is part of an emerging field of scholarship that weaves together social and ecological concerns about the future state of our food systems within the broader landscape of achieving low-carbon economic development and just outcomes for communities and environments.

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Research methods

The insights from this article are based on data collected over a three-year doctoral

Figure 1: Key considerations to inform just transition guidance for Aotearoa's dairy sector

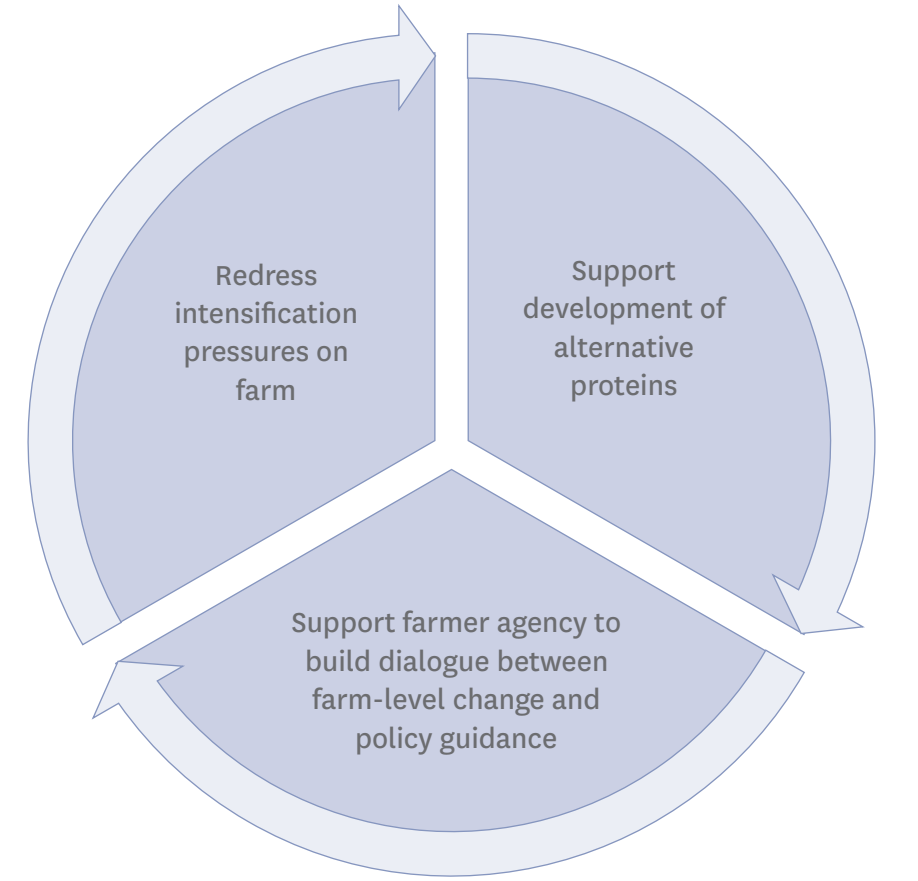

Table 1

Keyword searches for challenges to transition	Keyword searches for justice
transitions	justice
policy	social justice
government	community/ies
challenge/s	animal welfare
opportunity/ies	economy
future/s	economic development
synthetic milk	sustainability
plant-based	environment
precision fermentation	climate change
alternative proteins	social license[2]

project (2021–24) about the future of dairy in Aotearoa. Drawing on interviews with 63 diverse stakeholders across the nation's dairy ecosystem, workshops with dairy farmers and site visits to farms, a milk processing plant and a precision fermentation laboratory. The insights draw upon participants' visions for the future of the sector, with a focus on challenges and opportunities for the dairy industry. This type of engagement reveals how transitions are discursively constructed across a variety of actors (Wang and Lo, 2021). A typology of stakeholders is provided in the Appendix.

Interviews with participants were semi-structured, enabling participants to speak freely on topics of interest (Bryman, 2012) as they related to the broader questions about the future of Aotearoa's dairy sector. Transcripts were coded and analysed to focus on responses that related to themes of social, environmental, economic and political challenges for the sector, currently and in the future. To identify challenges to transitions and dimensions of justice within participant responses, keyword searches were undertaken, as summarised in Table 1.

Analysis of the transcripts was informed by White and Leining's (White and Leining, 2021, p.3) argument that a transitions process should be 'inclusive, informed and iterative', which includes understanding different stakeholder positions for future policy development (Heffron and McCauley, 2018). This is echoed in Loorbach's (2010) work on governance processes towards transition management, acknowledging that diverse networks of business, government, science and civil society can have shared visions and agendas for social reform and are increasingly influencing regular policies in areas such as energy supply or agriculture. Engaging with diverse stakeholders in this context helped to identify shared values and aspirations as well as conflicting views, adhering to the Just Transitions Aotearoa Group approach that effective just transition planning is grounded in fostering relationships, new ideas and innovative collaborations (Just Transitions Aotearoa Group, 2023).

Findings and recommendations

The data collected over the three-year study highlighted how transition processes in the sector will require the involvement of a range key actors, including farmers, industry representatives, alternative dairy producers, researchers, civil society, government and Māori, all of whom have a role to play in shaping the future of the industry. Key considerations that will shape future policy design principles and guidelines for the sector should consider the following: navigating intensification pressures, supporting the development of alternative proteins, and supporting farmer agency in the transition process. These are summarised in Figure 1.

Redressing intensification pressures

Aotearoa is uniquely placed to consider the challenges of dairy intensification[3] across global and local scales due to the role of Fonterra and its strategic partnerships with international customers, such as Nestlé. As observed across the Canterbury and Southland regions through the research

period, market drivers towards high productivity put additional pressure on farmers, who must balance profitability with environmental, social and economic sustainability. Increased productivity requires increased investment on farms, resulting in a more mechanised industry. This pushes dairy farmers to further compete in national and international markets, increasing the risk of more corporatised landscapes emerging that push out smaller-scale operators. For Aotearoa, dairy intensification, with its monoculture grasslands and commodity milk production for export, is not synonymous with sustainability and, indeed, actively harms human and non-human actors, yet it continues partly thanks to its clean and green marketing image (Bond, Diprose and McGregor, 2015). Intensification creates a vicious cycle where economic drivers are perpetuating unjust outcomes at almost every level of the food system. There are fewer but larger beneficiaries and increased milk volumes, which may have some cosmopolitan justice[4] benefits in terms of supporting access to food and some livelihood opportunities for future generations (Kaljonen et al., 2021). The where and how of food production will then need to continuously adapt to changing environmental conditions which may no longer be conducive to intensive pasture-based production. New production paradigms are needed, where sustainability is positioned as a 'moving target' (Gaziulusoy, Boyle and McDowell, 2013, p.105) which focuses on contextual conditions of environments, humans and diverse species, to improve understandings of dynamic conditions and possibilities.

It is also important to note that Aotearoa's dairy industry operates at multiple scales and that those scales are interconnected. The local dairy farmer is connected to global markets, and cattle wellbeing is dependent on technologies, regulations and processes that evolve in very different jurisdictions. Some of the just transitions scholarship argues that 'the most promising approaches to transition studies are those that integrate macro and micro levels of analysis' (Stevis and Felli, 2020, p.7). Such transitions should be a confluence of frameworks and practices that also respect non-human flourishing and species existence, ecosystem health (soil, water, air) and biodiversity, while keeping resource use within planetary boundaries (Kaljonen et al., 2021; Tribaldos and Kortetmäki, 2022; Vermunt et al., 2020). In the Aotearoa context, this also involves ongoing and ethical engagement with Māori across the country to recognise the past and ongoing injustices and give effect to te Tiriti o Waitangi, ensuring the empowerment of Māori people through appropriate regulatory and legal frameworks that can inform ethical and appropriate resource management strategies (Just Transitions Aotearoa Group, 2023, p.14).

> There is significant potential for industry and government, through shared goals of a just and sustainable dairy future, to support farmer agency and engagement at the farm level to inform transitions and policy design.

Support for development of alternative proteins

Fonterra recently invested in a precision fermentation start-up named Vivici, even releasing their first product to market, 'a nature-equivalent whey protein, beta-lactoglobulin' (Vivici, 2023). To ensure just and sustainable transitions for the dairy sector, the opportunities offered by such alternative protein production should avoid entrenching further intensification and cascading environmental impacts, as well as corporatisation and monopolies in the food system (Sexton and Goodman, 2022). Thus far, investments in lab-grown milk have focused on business models that have strong barriers to entry to potential competitors through intellectual property (IP) patents, trade secrets and enacting regulatory barriers (Howard, 2022; Guthman et al., 2022). A just transition should support efforts towards democratisation of knowledge and expertise, which could involve treating the intellectual property of new food technologies as a social good, one from which farmers and proponents of alternative proteins can collectively benefit. How IP is democratised is a challenge and requires more government investment and regulation to support not only diversified land use, but market opportunities that can treat IP as a social good, rather than a private asset to be commodified. In this way, primary food producers can also be included in the transitions process. Such processes may involve regulations that cap growth and encourage entrepreneurship of smaller-scale alternative dairy enterprises, rather than monopolisation of food producers, as in the current system. Continuous research and engagement with diverse stakeholders, which includes recognition of farmers and producers as key stakeholders in the shaping of new food systems, and interrogating the values of our food system are critical aspects in steering the dairy sector to more just and sustainable trajectories.

Support for farmer agency

Although advances in food technology have the potential to address environmental issues such as land use and emissions, the impact these advances have on primary food producers and rural communities is a key consideration for just transitions. Recognition of farmer agency and the development of policy dialogues that engage at the farm level of change, particularly in the context of alternative protein development, is needed to support just outcomes. As observed throughout engagement with participants and through the literature on transitions to alternative proteins,

farmers and rural communities are rarely examined in the proposed frameworks regarding alternative dairy futures (Lonkila and Kaljonen, 2021). Therefore, a focus on recognition justice is a key aspect of a just and sustainable transition, which includes meaningful engagement with stakeholders most affected by change. Further to this, there needs to be a clear acknowledgement that 'farmers' are not a homogenous group so a nuanced approach to understanding impacts of transitions must take into consideration the differences between small- and medium-scale dairy farmers, those who do not own land (sharemilkers) and farm workers (paid wages not salary). The Ministry of Business, Innovation and Employment has begun some of this work through its recent guide (Just Transitions Aotearoa Group, 2023); however, more work is needed to address the specificities of agricultural transition across different regions in Aotearoa. As economies shift towards low-carbon development, the new market opportunities offered by plant-based and precision fermentation dairy will shift society and environments too. If not managed carefully, these advances could reinforce existing inequalities or create new ones, furthering uneven impacts across people, animals and environments.

There is little clarity regarding the role of traditional dairy farmers within Fonterra's plans to pursue precision fermentation; nor is there firm guidance from national government in this area. If a just and sustainable transition to alternative forms of dairy is to occur, then dairy farmers and their interests and preferences should be central to those discussions. Continuous engagement and the co-production of knowledge around the challenges, impacts and opportunities of transitions are needed. There is significant potential for industry and government, through shared goals of a just and sustainable dairy future, to support farmer agency and engagement at the farm level to inform transitions and policy design. Such a balance requires engagement with diverse actors across the dairy ecosystem and consideration of how the future livelihoods of animals, environments and emerging alternative dairy enterprises can support efforts towards de-intensifying traditional dairy herds. Key risks must be considered regarding the distribution of benefits, especially if transitions are driven by growth-focused market logics and dominated by corporate investment. Such approaches may limit the inclusion of farmers' perspectives, which are crucial for meaningful agricultural land use change. Ultimately, a just transitions approach puts social justice at the heart of transformation research and management to support more inclusive and just pathways towards sustainability (Bennett et al., 2019).

As the climate changes, so too does the predictability of pastoral practices, creating further uncertain food futures. A just transition requires recognition that transitions to low-carbon development are inherently social and are shaped by a diversity of values, cultures and politics (Avelino et al., 2016; Avelino, 2017; Köhler et al., 2019). The transition towards intensification has been a disaster for many, but this has been hidden from view through the emphasis on economic profitability. Transitioning to more sustainable modes of dairy agriculture will require a just transition framework to ensure fair and equitable distribution of future costs and benefits for both traditional and novel dairy protein production.

Conclusion

This article has offered guidelines to enable a just transition for Aotearoa's dairy sector.

Table 1: Participants and their descriptions

Stakeholder type	N	Description
Academic	7	Participants working for Universities or Crown Research Institutes who were researching Aotearoa's dairy industry in some capacity. Researchers varied in their knowledge and expertise with some focusing on fresh-water ecology, while others worked on the future development of alternative proteins.
Activist/NFP	3	Each of these participants worked and/or volunteered for grassroots activist groups (for the environment or for animal rights) that share similar perspectives in terms of reducing herd numbers across the country. While attempts were made to interview participants who were pro-dairy farming in an activist capacity, these interviews did not transpire.
Dairy Farmer	19	This category of participants includes dairy farmers from across the country, though a majority come from the South Island in the Canterbury and Southland regions. These regions have experienced the most significant growth in dairy production in the last few decades, as explained in the introduction chapter. Dairy farmers tended to be white, middle-aged men – only 4 of the 19 dairy farmers identified as female.
Dairy Industry Representative	8	Dairy Industry representatives were from either DairyNZ or Fonterra.
Economist	2	These participants identified themselves as economists who actively study and report of the economics of dairy farming in Aotearoa in their professional careers.
Farm/Food Consultant	8	This participant group is made up of consultants of different expertise – some provide advice directly to farmers about farm planning and resource management. Other consultants work for alternative protein companies and provide advice on the marketing and sustainability of alternative dairy.
Government	4	These included participants from key governmental Ministries that manage transitions for different sectors of Aotearoa society.
Media/Journalist	5	These were participants who worked as independent content producers or for major news/media organisations across Aotearoa and have a record of researching and reporting on the dairy industry.
Alternative Dairy Representative	7	Participants in this category either owned or worked for Aotearoa-based plant-based or precision fermentation dairy businesses and initiatives.
Total:	63	

A sustainable transition is not as simple as merely reducing cattle numbers. It is a much more complex process and will require a diversity of ideas and efforts to steer the dairy sector towards more sustainable trajectories that also engage with the complexities of the geographical context, in terms of Tiriti obligations, industry and government roles facilitating intensification and diversification of the sector, and, finally, farmers' capabilities to adapt in the face of social, economic and environmental change.

A specific guide for agri-food transitions in Aotearoa would share the same principles as set out in the *Guide to Just Transitions*. The principles for agri-food transitions need to be grounded in contextual and relational understandings of what is already unfolding across different scales, from farm-level to national-scale environmental management and policies for the sector. In terms of government-led initiatives, the Ministry of Business, Innovation and Employment could lead the way in providing more detailed case studies for affected communities, while Treasury could engage in research towards investment and regulation to support IP in precision fermentation and safeguard these technologies as a national social good. Such initiatives will need to also consider broader economic diversification in rural communities, which should include supporting a shift away from intensive pastoral farming, embracing land diversification and supporting the growth of alternative dairy industries. A just transition framework is a useful and practical mechanism to guide the process for meaningful engagement with diverse stakeholders and communities towards achieving broader social, economic and environmental sustainability.

1 This refers to a 24–47% reduction in biogenic methane emissions below 2017 levels by 2050, including a 10% reduction by 2030.
2 Referring to community acceptance for intensive industries to operate; for further explanation of this, see Edwards and Trafford, 2015.
3 Intensification in this context refers to large-scale, high-resource and capital inputs for high productivity.
4 Cosmopolitan justice in the just food transitions literature emphasises the importance of global fairness and intergenerational justice, wherein transition pathways in one place should not cause disadvantage to or negatively impact the food security or wellbeing of distant, marginal or future populations (Tribaldos and Kortetmäki, 2022).

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