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‘As a farmer you’ve just got to learn to cope’: Understanding dairy farmers’ perceptions of climate change and adaptation decisions in the lower south Island of Aotearoa-New Zealand

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ABSTRACT

The impacts and implications of climate change – such as floods, droughts, heavy rainfall and increased regulation – are affecting dairy farming practices in the lower South Island (Te Waipounamu) of Aotearoa-New Zealand. Adapting to these changes, in an equitable and transformational manner, is dependent on understanding the underlying root causes of vulnerability alongside local knowledge and values. We apply an intersectional values-based and contextual analysis to describe how past and present processes of agrarian change interact across different farmer identities to influence adaptive pathways. Local knowledge, place-based experience, values and perceptions of fairness intersect with different facets of a farmer’s identity – such as financial capacity, land ownership status, debt arrangements, age and gendered participation – to enable or constrain adaptive action. Notably, notions of fairness, whether real or perceived, vary across farmer groups, and influence the kinds of adaptation activities that dairy farmers are willing, or potentially able, to engage in. The results call for more contextualised engagement with farming communities, and highlight the need to build a shared understanding of the complex historical, social, economic, cultural and environmental drivers of past, present and future change, in this highly productive, yet risky, agricultural landscape.

1. Introduction

The expansion of Aotearoa-New Zealand’s dairy industry over the last three decades, has radically transformed regional landscapes, generating local prosperity and social change albeit alongside adverse environmental outcomes and substantial greenhouse gas (GHG) emissions (Barnett and Pauling, 2005; Forney and Stock, 2014). Despite this growth, dairying now stands on the brink of large-scale change, driven in part by the physical impacts and corresponding legislative implications of climate change, alongside recent freshwater reforms. As farmers navigate these new regulations, including water and probable future reductions in GHG emissions, they must also manage the more direct impacts of climate change, some of which – such as increased flooding, dry spells, and heavy rainfall events – are already beginning to manifest

(Frame et al., 2020).

Floods and heavy rainfall are not new to the lower South Island and have long been a part of the region’s pastoral and pre-colonial landscape. Notably, in February 2020 record-breaking rainfall fell across the lower South Island, instigating a state of emergency and mass evacuations as farmland along the Maitai River was inundated with floodwater. This event led to severe on-farm infrastructure damage (fences, culverts, laneways and roads), loss of baleage² as it floated downstream, destruction of pasture and paddocks, and in some cases the loss of revenue if milk tankers lost access to a property. The February 2020 flood event highlights some of the challenges facing the dairy industry in an increasingly warming world. The intensity of future floods and heavy rainfall events is projected to increase, placing dairy farms at greater risk (Paulik et al., 2021). In the south, this risk is exacerbated by local soil

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² Baleage or grass silage, is pasture that is preserved and stored in bales and wrapped in plastic.

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conditions and winter grazing practices that cause ‘pugging’³ during wet weather. Together with projections of changing climatic conditions across the country over coming decades (Lawrence et al., 2022), there is a clear need to adapt current farming systems to better suit the future climate.

Adapting to change is an inherent part of farming, and many farmers throughout the Asia-Pacific have already begun the process of incrementally adapting to long-term shifts in climate and extreme events (Beilin et al., 2012; Lefale, 2010; Naess, 2013). Aotearoa-New Zealand’s dairy farmers - who are already well experienced dealing with floods and heavy rainfall (Dynes et al., 2010; Kenny, 2010) - are no exception. Despite this, few qualitative intersectional oriented studies focus on farmers’ experiences of climate change, acknowledging them as capable experts who are actively adapting to change, particularly in high-income nations (for exceptions see Burton and Peoples, 2014; Fletcher and Knuttila, 2016; Soubry et al., 2020). Equally important is the need for studies that situate these local adaptations, or limits to adaptation, in the context of the wider socio-economic and political structures that determine resource distribution (Adger, 2016; Pelling, 2011; Ribot, 2011).

In this article, we examine the structural and locally embedded contextual drivers that enable or constrain vulnerability and adaptation to the impacts and implications of climatic change in a wet, flood prone, yet highly productive agricultural region. Focusing on the experience of dairy farmers in the lower South Island, the article begins with an overview of vulnerability and adaptation studies in agrarian contexts, followed by a discussion of how current land use practices have emerged within the past and present political economy. We then describe our methodological approach followed by a discussion of how place, experience, wellbeing, values and perceptions of fairness interact with adaptation decisions. The article concludes with a discussion of varied adaptation pathways across different lower South Island farmer identities and the implications of this work for the development of contextualised, equitable and transformational climate change adaptation.

1.1. Overview of social vulnerability and climate change adaptation studies in agricultural contexts

The growing literature on the vulnerability and adaptation of agricultural systems to the impacts of climate change calls for more in-depth and situated qualitative studies, particularly in high-income agricultural contexts (Cradock-Henry et al., 2019; Soubry et al., 2020; Sumane et al., 2018). Within the climate change literature, vulnerability is now widely recognised as a state or condition embedded within the political, economic, environmental, and social context (Ford et al., 2010; O’Brien et al., 2007; Rahman and Hickey, 2020; Wisner et al., 2004). Originally stemming from a different epistemic background to vulnerability, adaptation is defined as the ‘adjustments in ecological-socio-economic systems in response to actual or expected climatic stimuli, their effects or impacts’ (Smit and Wandel, 2006, p. 879). These adaptations may be autonomous, involuntary, planned, passive, reactive or anticipatory, and to be successful should address the socio-political, economic, and cultural interactions that determine access to livelihood resources (Eriksen et al., 2011; Rahman et al., 2021). Increasingly, scholarship on adaptation acknowledges that people are not just passive recipients, but also possess the capacity to overcome and adapt to change (Tanner et al., 2015), albeit influenced by access to resources, local power dynamics, and other socio-cultural, economic, and political dynamics.

Some studies of adaptation have, however been critiqued for relying heavily on top down and technocratic fixes (Bosomworth and Gaillard, 2019), shifting the focus from cause to response (Pelling, 2011; Ribot,

2011), while overlooking historic power imbalances and structural inequalities (Adamson et al., 2018; Marino and Ribot, 2012; Nightingale, 2017). Empirically, studies have shown that the majority of the documented adaptations that farmers engage in are incremental, focused on the short-term maintenance of current day farming practices, rather than the pursuit of path-shifting transformative change (Fedele et al., 2019; Vermeulen et al., 2018). For example, Beilin et al. (2012) describes how farmers in Australia’s Murray-Darling Basin have been able to ‘extensify, intensify and diversify in response to pressures’ (p. 464), potentially locking in undesirable pathways or maladaptive outcomes in the process.

Yet, climate change adaptation does not always need to rely on technocratic fixes or incremental changes and some studies push for the transformational change of existing systems. Pelling (2011) argues for a more radical, progressive and political interpretation of climate change adaptation, contending that so far ‘Adaptation has been framed in terms of identifying what is to be preserved and what is expendable, rather than what can be reformed or gained’ (p. 1). While coping strategies and incremental adaptations are focused on altering current systems to accommodate future change, the kind of transformational adaptation that Pelling (2011) and others (see for example Abel et al., 2016; Few et al., 2017; O’Brien, 2012; Rickards and Howden, 2012) call for is in Fedele et al.’s (2019) words ‘restructuring, path-shifting, innovative, multiscale, systemwide, and persistent’ (p. 116).

Importantly, transformational change requires understanding and addressing the structure and root causes of present day vulnerabilities (Bohle et al., 1994; Kelly and Adger, 2000; O’Brien, 2012; Pelling, 2011; Ribot, 2011). Indeed, adaptation plans that overlook the local context and the multiple stressors facing communities, are at increased risk of perpetuating maladaptive responses (Eriksen et al., 2011; Rahman et al., 2021). Likewise, planned adaptations that neglect the embedded inequalities that exist within different groups of society risk further marginalizing impacted communities (Fletcher and Reed, 2022). Studies of transformative change should therefore consider the over-arching political, economic, environmental, and social conditions that determine unequal access to resources across different groups, including gender, ethnicity, class and age (Fletcher and Reed, 2022; Fletcher and Knuttila, 2016). In agrarian contexts, this can include the interplay of government policy, markets, lending arrangements and local capacity among others, that determine the resources differently positioned farmers may have to overcome livelihood shocks and stresses (Scoones, 2009). Complex and grounded understandings of vulnerability also consider how historical processes have shaped dominant land use practices and the distribution of power and resources within society (see Adamson et al., 2018; Parsons and Nalau, 2016).

While the studies cited above broadly argue for a more political and transformational approach to adaptation, there are also growing calls for climate change adaptation theory and practice to pay further attention to how risks are defined and what constitutes a ‘just’ response (Adger, 2016; Forsyth, 2014; Żebrowski et al., 2022). In particular, Forsyth (2014) argues that climate change solutions should not counteract legitimate economic growth, particularly for vulnerable populations, and must pay more attention to how risks are defined and what issues affected people see as most urgent. Importantly, the adaptation decisions that farmers make are rarely made in the context of responding to climate change impacts alone, and are influenced by daily livelihood realities, alongside local values, experience, and perceptions of fairness (Adger, 2016; Naess, 2013; Sanderson et al., 2018; Tanner et al., 2015; Wreford and Adger, 2010).

Local farmer held knowledge has the potential to contribute significantly to our understanding of the local and contextual factors that aid or hinder transformational climate change adaptation. Various authors argue that the discourse of climate action has centred on expert knowledge, while overlooking more interdisciplinary studies that consider the interests and knowledge of citizens, societies, and people in general (Beck, 2010; Jasanoff, 2010; Yeh, 2016). Jasanoff (2010)

³ Pugging is caused by the tramping of wet soil by heavy livestock (often as they consume winter crops) causing soil compaction, a reduction in soil fertility and soil loss, which reduces water quality in local streams and aquifers.

explains how these scientific assessments can separate climate knowledge from meaning, articulating how ‘Climate facts arise from impersonal observation whereas meanings emerge from embedded experience’ (p. 233). Arguing that ‘local and farmers’ knowledge matters!’ Sumane et al. (2018, p.232) found that farmers’ informal practical knowledge makes a significant contribution to sustainable and resilient agricultural practices. Given the interdependency between successful farming and anticipating or responding to climatic events, farmers often possess in-depth knowledge of local weather and climatic processes. This is particularly true in Aotearoa-New Zealand, which having warmed by around one degree over the past century (Ministry for the Environment, 2018), means that many farmers have already noticed a shift in local climatic conditions (as will be discussed below). This observational knowledge – combined with farmers’ vast experience dealing with changes in global markets and past climate extremes (Dynes et al., 2010; Kenny, 2010) – is an important and often overlooked resource that has the potential to guide and inform locally relevant adaptation planning (Naess, 2013).

1.2. An integrated and intersectional understanding of climate change adaptation in agrarian settings

Effective adaptation requires in-depth and situated understandings of how decisions and actions are embedded in environmental, social, economic and political contexts (Fletcher and Knuttila, 2016). Equally important is the need to understand how values, experiences, and local knowledge shape perceptions of adaptation. As Adger (2016) describes, the political economy interacts with local understandings of place, wellbeing, and fairness, to affect how decisions emerge and gain legitimacy. Unravelling barriers and enablers to effective climate change adaptation at the local level therefore requires integrated and multi-scalar approaches that consider structure alongside local values, knowledge, and perceptions of fairness (Abel et al., 2016; Gorddard et al., 2016; Wreford et al., 2017).

Intersectional research is a methodological approach that bridges structure and agency, context and values. Intersectional analyses can illustrate the multiple facets of farmer identity and how this shapes vulnerability and adaptation (Thompson-Hall et al., 2016). As articulated by Kaijser and Kronsell (2014) ‘An intersectional analysis of climate change illuminates how different individuals and groups relate differently to climate change, due to their situatedness in power structures based on context-specific and dynamic social categorisations’ (p. 417). Intersectional research can help to explain why harms and losses are experienced differently among social groups, while also acknowledging the structural causes of difference and inequalities that drive vulnerability (Kaijser and Kronsell 2014; Thompson-Hall et al., 2016; Walker et al., 2021). For example, studies have shown that the impacts of climate change are gendered in drought affected regions of Australia (Alston, 2010), and the Canadian Prairies (Fletcher and Knuttila, 2016). Likewise, in a study of wildfire impacts in northern Saskatchewan Canada, Walker et al. (2021) applied an intersectional analysis to link context (why risks are experienced differently between social groups) with values-based approaches (lived experiences of hazardous events). While recent work has importantly advanced intersectional research to understand farmer vulnerability and adaptive strategies in industrialised nations (Fletcher and Reed 2022; Thompson-Hall et al., 2016), it remains an emerging research agenda, particularly in Aotearoa-New Zealand.

Here we build on the work of Adger (2016), and related intersectional studies of climate change adaptation (see Fletcher and Reed 2022; Thompson-Hall et al., 2016; Walker et al., 2021), to describe how local values and knowledge interact with the overarching structures that shape land allocation and resource use, which influence adaptation attitudes and behaviours among lower South Island dairy farmers. Our analytical approach (Fig. 1) integrates the political, social, cultural and economic contexts (including place and experience, values, and

perceptions of fairness), to understand different adaptive preferences of dairy farming groups. By place and experience, we refer to the way climate impacts are embedded and experienced within local places, and the way this lived experience shapes perceptions and participation in adaptation practices (see Adger, 2016; Jasanoff, 2010; Marlon et al., 2021; Prokopy et al., 2015; Walker et al., 2021). Wellbeing and values refer to how losses and benefits of climate change impacts are distributed within society (Adger, 2016), and what matters most to people in their daily lives (see Tschakert et al., 2017 for a discussion of loss and values). Finally, fairness – whether real or perceived – is shown to heavily impact how likely people are to view official government policies and participate in local level adaptation practices (Adger, 2016). While our study was primarily concerned with adaptation to the physical impacts of climate change, we acknowledge that adaptation is also influenced by market forces and government policy, be it environmental regulation, GHG mitigation or otherwise (Räsänen et al., 2016). We have therefore considered adaptation within the context of multiple stressors on decision-making processes (Eriksen et al., 2011; Gorddard et al., 2016), rather than proscribing it as a response to the physical impacts of climate change (such as floods or droughts) alone.

A note on fairness and our research study site:

Dominant framings of climate justice suggest that those who have contributed the most to climate change have a moral responsibility to implement solutions (Adger et al., 2006), and that research should focus on protecting the most vulnerable (Dow et al., 2006). Dairy farmers are not typically considered a ‘vulnerable’ group, if we consider the environmental impact of Aotearoa-New Zealand’s dairy industry, the fact that farms can be highly profitable, and that pastoral land was often unequally acquired from Māori (see below). However, at the farm-level the impacts of climate change will still be experienced unequally, potentially leading to ‘winners and losers’ within agricultural systems (see Burton and Peoples, 2014). In order to improve adaptation outcomes for all of society, we posit it is necessary to understand the differentiated vulnerabilities that may be experienced by lower South Island dairy farmers, while acknowledging and building a shared understanding of the historical, social, economic, cultural, and environmental complexities that this entails.

2. The making of the lower South Island’s agrarian landscape

In recognising that adaptation studies should be grounded in the context of historic, socio-economic and political processes that shape local resource use (Fletcher and Knuttila, 2016), we begin our study by describing the lower South Island’s past and present agrarian landscape. This begins with Māori occupation, to the expansion of pastoral land use and interactions with climatic events. By ‘the lower South Island’ we refer to the regional council areas of Southland and the southern part of Otago, also known as Murihiku (Fig. 2).

2.1. A brief history of land acquisitions and transitions in Murihiku

Māori, the indigenous people of Aotearoa-New Zealand, have a long and rich connection to the lower South Island that began long before the emergence of pastoral agriculture. Murihiku can be defined as an area of the lower South Island, extending south of the Waitaki River and east to the Waiau River (excluding Rakiura Stewart Island), which was settled by Polynesians at 800 to 1200 years ago (Dacker, 2006) (our study sites fall within the southern stretch of this area). Prior to the arrival of European sealers and later run-holders (who leased land from the Crown for livestock grazing) in the late 1700s and mid-1800s respectively, Māori⁴ settlements were scattered throughout Murihiku, providing important centres for food gathering (mahika kai) and stone shaping (Dacker, 2006). However, in the mid 1880s the Crown began the

⁴ Descendants of the Polynesian voyagers.

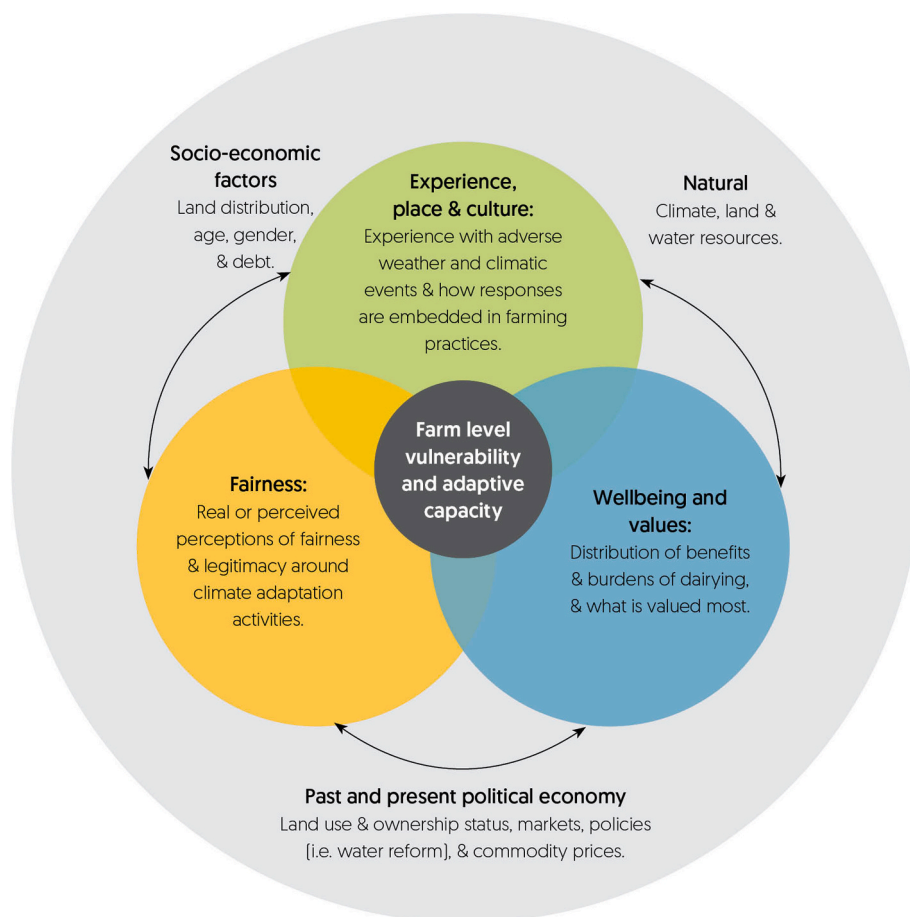


Fig. 1. The analytical framework used in this study that embeds vulnerability and adaptive decisions within the context of broader economic and political structures, alongside local knowledge and values and different farmer identities (influenced by [Adger, 2016](#) & [Walker et al., 2021](#)).

unequal acquisition of this indigenous held Ngāi Tahu⁵ land,⁶ marking the beginning of pastoral farming in the south. Māori guided the first of the European settlers into the Southland interior and provided the necessary labour to set up homes and farms, yet once agriculture was established, they were left without access to adequate land resources to participate in, and benefit from, this new economy ([Dacker, 2006](#)), a situation that largely persists today ([Wynyard, 2019](#)).

Making way for livestock pasture and cropping (primarily oats and wheat) dramatically altered the landscape, as native tussock and forests were burnt, rivers straightened, and wetlands drained ([Moran et al., 2017](#)). While early agriculture focused on sheep, the combination of the South's wet climate alongside its fertile soils meant that dairy farming was also an early feature of colonial pasture-based agriculture. Initially, dairy herds were small and served household needs; however, as opportunities to export cheese and butter to the UK grew, small dairy factories emerged ([Waite, 1948](#)). Despite the recent intensification of dairy from the mid-1980s, sheep and beef remains the predominant land use in Southland, still covering 56% of developed land ([Moran et al., 2017](#)).

⁵ Ngāi Tahu are the principle Māori iwi (tribe) of the Te Waipounamu, the South Island.

⁶ Kemp's purchase of the Ōtākou block (extending south of the Otago Peninsular to Nuggets) in 1844, and Mantell's purchase of the Murihiku Block (which aligns with Environment Southland Regional Council boundary) in 1853, failed to provide Māori with sufficient land to successfully engage in economic activities, or food collection. In the Murihiku purchase, the western boundary was misrepresented to incorrectly include Fiordland ([Dacker, 2006](#); Ngāi Ngāi Tahu, 1991).

2.2. The expansion and intensification of dairying

While dairying has long been a part of the lower South Island's agrarian landscape, its expansion and intensification in recent decades can be traced to a confluence of factors. From 1950 to 1975 sheep heavily dominated the landscape ([Moran et al., 2017](#)), a pattern that was disrupted from the mid 1980s with the introduction of new neoliberal government policies that saw the removal of agricultural subsidies and deregulation of the market (for a more in-depth discussion see [Burton and Peoples, 2014](#)). [Forney and Stock \(2014\)](#) describe how these changes, alongside the formation of Fonterra (a New Zealand based multi-national dairy co-operative), facilitated a gradual retreat from sheep and intensification of dairying, challenging traditional sheep farming identities in the process. Amidst a background of increasing land values and at times high dairy payouts, which provided more regular cash-flow, conversion was seen as a way to guarantee the longevity and future of the family farm ([Forney and Stock, 2014](#)), while also reversing population loss and revitalising local communities ([Greenhalgh and Rawlinson, 2013](#)).

The early days of the dairy boom provided opportunities for new entrant farmers to progress up the 'dairy ladder' from sharemilking to land ownership, and for landowners to employ more people. It also encouraged the migration of farmers from Canterbury and the North Island, particularly Waikato, southwards to the 'land of opportunity, milk and money' ([Greenhalgh and Rawlinson, 2013](#), p. 8). In comparison to the North Island, in Southland dairy farmers could own more land, farm more cows, and avoid harsh droughts ([Greenhalgh and Rawlinson, 2013](#)). Currently 12 per cent of Aotearoa-New Zealand's dairy cows are located in Southland (LIC & DairyNZ, 2020), and in 2018



Fig. 2. Location of study site and localities of participants in the lower South Island, which includes part of the Southland and Otago regional councils.

dairy farming and processing accounted for 13 per cent of Southland's, and four per cent of Otago's, total GDP (NZIER, 2018).

While dairying has brought important economic and population growth to the lower South Island, it has also come at a significant environmental cost. According to Jay (2007), the dairy industry is tied to a 'production ethos and a business efficiency model' (p. 275). Highly capitalised and leveraged land has caused intensification (Barnett and Pauling, 2005; MacLeod and Moller, 2006), which combined with the historical draining of wetlands to make way for pasture growth allows high levels of contaminants (through effluent and the application of fertilisers) to enter natural waterways (see Baskaran et al., 2009; Foote et al., 2015; Jay, 2007; Moran et al., 2017). In the south, soil 'pugging' is a particular concern, and while improvements to winter grazing practices have been made (including the construction of large indoor wintering barns that eliminate the risk for some), it remains a point of political contention and has been the subject of animal rights activism (for example Tulloch and Judge, 2018). Notably, the difficulties associated with wintering stock, sheep and cattle, are neither new, nor insignificant to overcome. A local Southland councillor reportedly relayed how an extremely wet winter in 1972 meant best practices could not overcome soil damage, a situation that contributed to severe mental health impacts and tragically numerous suicides amongst farmers that year.⁷

2.3. Farming with floods

Throughout the land acquisitions and conversions, floods have remained a prominent feature of the farming experience in the south.

⁷ <https://www.odt.co.nz/rural-life/rural-life-other/stern-response-winter-grazing-post>.

Much of this dairy land is located in flood prone areas, particularly situated along the Mataura River and Clutha River Mata Au (Fig. 2). Large floods have inundated low-lying land surrounding the Mataura River and the lower Clutha Mata Au since at least the 19th century, in some cases causing livestock deaths, damaging crops and pasture, and depositing silt and sand on farmland and swamps. As mentioned in the introduction, the most recent and damaging flood of the Mataura River occurred in February 2020, an event that inundated farms, eroded banks and paddocks, transported baleage downstream, damaged fences, and disrupted milk tankers' access to properties (pers. comm. Environment Southland, 16/03/21). Despite no significant events since 1999, floods are also fixture of the Clutha River Mata Au (Hornblow et al., 2016) and in the past have damaged farmland, caused livestock deaths, and encouraged the migration of some, yet not all, farmers uphill (Rutherford, 1998).

The history of land acquisitions, conversions and flood events as described above, sets the foundation for contemporary vulnerabilities and the adaptive capacity of lower South Island dairy farmers. Below we describe the methodology we used to understand how these historical processes interact with present day values, knowledge and perceptions of climate change adaptation across different farmer identities.

3. Research methods

This study draws its findings from a series of qualitative interviews conducted in the lower South Island, between February and June 2021. A total of 27 semi-structured interviews were held with dairy farmers (19 males, 2 females and 6 husband-wife couples). Most of the interviews occurred on farms located in what is locally termed the 'Southland Flat', encompassing the fertile floodplains bordering the Mataura River such as Edendale, Whydham and Seawards Down, or in proximity to the Clutha River-Mata Au (Fig. 2). Participants were

selected through a combination of targeted and snowball sampling. Targeted participants included industry leaders from Dairy NZ's farmer database, the Federated Farmers and Rural Support Trust websites. These participants then informed the snowball sampling approach, which followed farmers recommendations and introductions, alongside the researchers' own existing networks. Prior to fieldwork, an ethics protocol was submitted and approved by a university ethics committee.

Participants were initially contacted via the phone, and if willing to participate, a time and place for an interview was arranged. Interviews were guided by a list of pre-determined questions; however, there was room to explore new or unexpected topics that influence the 'decision-making context' (Gorrdard et al., 2016). Interviews generally lasted one hour and followed a typical structure: (1) an explanation of farm size, structure (including ownership arrangements), and land use practices; (2) the impacts of, and responses to, weather events on farm; (3) experiences of long-term shifts in weather patterns (if perceptible); (4) the adaptation strategies farmers draw on to overcome shocks and stresses (climate induced or otherwise); (5) livelihood diversification strategies; and (6) discussion of the biggest perceived challenge(s) facing current dairy practices and the dairy industry more generally. Towards the end of each interview, most informants also reflected on whether they see themselves as a dairy farmer in the long-term, and if not, what alternate options are available.

Interviews were audio-recorded with participants' permission and transcribed using artificial intelligence software (Otter AI). All interviews were replayed and the transcriptions manually corrected for transcription errors by the first author, and identifiable information removed. The researchers then conducted thematic analysis, manually identifying and collating responses relating to the three key themes of our conceptual framework: (1) local understandings and experience of climate change (both physical impacts and government regulation), (2) local farming cultures and values, and (3) perceptions of fairness concerning mitigation and adaptation strategies. Participants responses to each key theme were triangulated to ascertain nuance and consistency of views. Responses to these core themes were compared across different farmer groups, specifically: land ownership status (owner-operators, sharemilkers and equity partnerships), age, farm size, stocking rate, geographic location, gender participation, and level of experience. While we attempted to interview an equal number of farmers of different gender, men are more likely to be viewed as the farm 'primary farmer' (Burton et al., 2020; Fletcher and Knuttila, 2016) and were more likely to be listed as the main farm contact and to accept an interview invitation.

4. The local and contextual drivers of climate change adaptation

Drawing on qualitative fieldwork data, below we describe how the lower South Island's agrarian history (described in section 2 above) interacts with locally embedded experiences of place, values and perceptions of fairness to contribute to present day vulnerability and adaptive decision making. In particular, we describe how participation in, or perception of, adaptation activities (including land use diversification, intensification, construction of wintering facilities, and decisions relating to farm succession) varies – or in some instances remains consistent – across different socio-economic farmer groups or identities.

4.1. Experience, place and culture of lower South Island dairying

Lower South Island dairy farmers possess a wealth of place-based experience dealing with weather events, such as floods, heavy rainfall and in some areas, extended dry periods. During interviews, farmers explained how they respond to adverse weather events and their common coping strategies (Table 1). Older and experienced farmers recounted their experiences of the floods of the 1970s, the 1998–99 El Niño event, and even the winter conditions caused by the 1991 Pinatubo eruption in the Philippines. Farmers draw on this body of place-based

Table 1

Some of the coping mechanisms and incremental styles of adaptations undertaken by dairy farmers to manage and overcome climatic events in the lower South Island.

Flood events	Heavy rainfall	Dry spells
Relocating livestock to high ground (on their own or a neighbour's farm).	Following best practice winter grazing principles (such as grazing from the top of a slope downhill).	Importing palm kernel expeller.
Importing feed or drawing on stored baleage to compensate for pasture damage.	Experimenting with novel grazing practices (such as cell grazing and back fencing).	Investing in irrigation.
Relocating stock to graziers.	Planting alternate winter crops such as oats or laying straw over mud.	Unloading stock early.
Moving to a 16-h or once a day milking schedule.	Shifting stock to stand off pads in bad weather.	Growing a summer crop, such as turnips.
Drawing on the assistance of the 'Farmy Army' ^a to help with on-farm clean up (particularly fixing fences).	Wintering stock off farm.	
Ensuring important infrastructure and assets, such as milking shed and baleage, are on high ground.	Investing in a large wintering shed facility.	
Selling the farm or seeking sharemilking opportunities elsewhere.		

^a The 'Farmy Army' was a volunteer group instigated by Federated Farmers who organised on-farm assistance following the February 2020 floods (<https://www.nzherald.co.nz/the-country/news/farmy-army-helps-flood-affect-ed-southland-farmers/7YNN6BRT4H2XFDLGH2JDNEBCE/>). See also Smith et al. (2011) on how communities underpin household capacity to respond to adverse events.

knowledge to cope with adverse events and incrementally adapt to change, and for some, this experience builds confidence in the success of future adaptations, as one farmer articulated: '*as a farmer you've just got to learn to cope*' (pers. comm. male dairy farmer, Clydevale, 20/07/21).

In addition to knowledge and experience dealing with adverse weather events, various older farmers have observed longer-term climatic changes over their own farming career and noted changes such as reduced frost and snow days, overall milder winters, delayed seasons, and more extreme events – observations that are consistent with future climate projections for the region. For example, one experienced farmer noted that he could no longer walk across what was once a frequently frozen duck pond during the winter months: '*It doesn't freeze as much now as what it used to*' (pers. comm. male dairy farmer, Woodlands, March 30, 2021). The literature describes how as farmers observe the direct impacts of climate change (Mazur et al., 2013; Prokopy et al., 2015), risk perception shifts from abstract or distal, to real and proximal (Menapace et al., 2015), shaping intentions to adapt (Adger, 2016; Marlon et al., 2021; Rahman and Hickey, 2020; Wheeler et al., 2021). Indeed, first-hand experience of long-term change and devastating flood events (i.e. the 2020 Mataura River flood event), combined with current conversations circulating within the industry (particularly around genetic modification of livestock to lower methane production, and the recommendations made by the Climate Commission to destock Aotearoa-New Zealand's livestock industries), has (re)invigorated discussions within the farming community around climate change, as one dairy farmer acknowledged: '*I think it has sort of changed from people being sceptical to what are we going to have to do?*' (pers. comm. male dairy farmer, Winton, 18/05/21).

Yet, increased awareness of climate change does not always translate to adaptation action (Niles et al., 2016). Despite first-hand experience of change, many farmers we spoke with, both young and old, took a cautious, 'wait and see' approach to acting on climate projections and explained they will instead make changes when they physically see a need. This distrust in modelled climate projections, was reflected in the many statements we heard that conflated weather and climate projections, through the reasoning of '*they can't get tomorrow's weather right*'

(pers. comm. male dairy farmer, Winton, 18/05/21). Indeed, a similar study of Midwest farmers in the US, suggests that uncertainty around future scientific climate projections limits farmers' justifications to change agricultural strategies and practices (Morton et al., 2017). One informant noted that farmers wouldn't invest in new climate safe practices or infrastructure *'until they can actually physically see what they need to be doing because something else might come along and wallop them beforehand'* (pers. comm. retired female dairy farmer, Invercargill, 29/03/21). This view was reiterated by another farmer who stated that while long-term climate projections might inform *'better planning'* went on to state: *'but I wouldn't trust it and I wouldn't invest in it'* (pers. comm. male dairy farmer, Brydone, 18/03/21).

Furthermore, while climate change is likely to increase the frequency of adverse weather events, gradual persistent long-term changes in climate might not bring all bad news for lower South Island dairy farmers. When we discussed the results of regional downscaled climate projections for mid- and late-century, which indicate milder winters, warmer summers, and increased rainfall, many farmers said they would welcome the changes as it would lengthen the pasture growing season and increase access to water resources (for a related discussion of climate change opportunities for farmers in Nordic countries see Sorvali et al., 2021). One farmer reflected on how local farmers perceive the benefits of future projections in the following terms: *'It's hard for New Zealand to kind of understand when you go outside, and you breathe fresh air that there is a problem. And particularly in Southland, you kind of go oh a bit of global warming, that would be quite good. But what we're actually seeing I think particularly in the last sort of maybe five years is more extreme events. Just nice days like today, bizarrely warm for April in Southland and then tomorrow there'll be torrential rain, like 70 [millimetres]. You know, all the floods that happened in Gore last February. We're just seeing stuff that's not normal. And people would say it was a one-in-100-year event, but 100-year events are happening twice a year.'* (pers. comm. male dairy farmer, Winton, 20/04/21).

Despite this local knowledge and first-hand experience of climate change, weather events are not experienced equally across all farming groups or identities. For example, due to discounted land prices it is often farmers with the least financial reserves who end up occupying the most flood or 'pugging' prone land, leaving them vulnerable to floods or heavy rainfall events (a pattern reflected in many contexts globally, see Wisner et al., 2004). This is particularly true for some stretches of land adjacent to the Mataura River that were inundated during the recent flood event: *'Well across the river, there's four farms for sale over there right now. And they've always been discounted because they're floodable. So, these kind of farms go to you know, the first time farmers, I mean it's great country ... great if you don't get floods.'* (pers. comm. male dairy farmer, Gorge Road, 18/05/21).

Overall, most informants recognised that climate change is occurring,⁸ yet they self-identified as already very adaptable to change (see also Dynes et al., 2010). Indeed, the process of converting to dairying itself was an adaptation decision made by some of the informants as a response to deregulation (Wilson, 1994), and for other dairy farmers who shifted south to avoid harsh North Island droughts. Unsurprisingly, climate change is not viewed as the most pressing issue facing current farming practices (see also Wreford and Adger, 2010). Most farmers felt that they will continue to adapt their farming practices incrementally as needed, while maintaining what they value most, which for many lies in their occupational identity and attachment to a farming lifestyle, as described below.

⁸ This acknowledgement did not always extend to the recognition of anthropogenic causes to climate change and sometimes was limited to descriptions of a 'cyclical' climate.

4.2. Wellbeing and values: intensification and the valorisation of farming lifestyles

It is now widely recognised that fair climate change adaptation needs to be situated in the context of local values and wellbeing, as this determines the kinds of losses that are experienced and how adaptation decisions are prioritised (Adger, 2016; Graham et al., 2018; Tschakert et al., 2017). During interviews we found that farming lifestyles and views of food production were valorised among informants, and this was shown to influence perception of adaptation strategies. For example, while some farmers showed a clear preference for livestock farming, others noted that they would diversify their modes of production (for example, into oats or horticulture) given adequate resources and the opportunity to remain in farming.

While Aotearoa-New Zealand's dairy industry has been driven largely by values relating to production efficiency, there is also clear evidence of environmental care and long-term stewardship among farmers (Jay, 2007). These values co-exist in the lower South Island, with many farmers committed to improving the land for future generations (i.e. through improved pasture management or riparian plantings). We also found that decisions to build a wintering facility sit at the confluence of these productivist and stewardship values. Indoor wintering facilities overcome the environmental impacts of wintering cows outdoors on crops (i.e. it reduces soil damage caused by 'pugging') and reduces exposure to future climatic risks (Beukes et al., 2011). Yet, we found that wintering facilities are costly and therefore only an option for certain financially capable farms. Furthermore, they are more likely to be adopted if they are seen to improve the economic and environmental performance of a farming system, rather than as a direct response to climate change alone (for a similar example from the United States see Davidson et al., 2019). One farmer described the decision to build a barn based on the heavy impact winter grazing was having on soil and water quality with the following: *'We were falling well short of the mark, there's no hiding from it, we were failing miserably. So, I had to do something'* (pers. comm. male dairy farmer, Dacre, 16/03/21).

However, housing cows indoors is sometimes at odds with the value some Southland farmers place on conventional outdoors and grass-fed dairying, as one older farmer articulated how keeping cows inside *'is not the New Zealand farming way'* (pers. comm. male dairy farmer, Winton, 20/04/21). Furthermore, the capital outlay often encourages further on-farm intensification, as discussed in more detail below. Other additional barriers to their uptake that were cited during the interviews included: costs (and reluctance of banks to loan for barns), disease (in particular mastitis), cleanliness, joint health, animal fitness, need to transport food to the barn, general uncertainty around future consents, greater workloads (including milking during winter), and the risk they pose to Aotearoa-New Zealand's market reputation for open pasture dairying. One informant articulated how the cost and culture of wintering animals does not fit with their ideals of a farm system: *'We can't afford a wintering barn. I think people have to be very careful what they wish for. Because if you put up a wintering barn suddenly, you're sending that farm down a very intensive route with a lot of imported feed and an increased stocking rate. And I personally don't want a wintering shed and to be milking all year. I want to stick to a grass-based farm system because that's what I enjoy.'* (pers. comm. female dairy farmer, Tapanui, 27/07/21).

While investing in a wintering facility can help farmers to overcome present and future climatic risks, we caution that this path may also potentially introduce other livelihood stresses and lead to poor mental health and wellbeing outcomes, especially for farms without substantial financial capacity. In the lower South Island context, wintering facilities are associated with higher input systems that require more people, longer working hours, year-round milking, and a greater dependency on what is already a limited pool of staff (for a further discussion see Rawlinson et al., 2013). In line with recent findings from studies in Norway, we caution that livestock intensification can negatively impact farmer wellbeing, optimism, and level of stress (Hansen and Østerås,

2019; Hansen et al., 2020). For example, one female dairy farmer explained the potential fallout associated investing in a wintering barn with: *‘It would put people under a lot of strain, if you put up a wintering barn, and you can’t really afford it, it’s going to suck millions of dollars’* (pers. comm. female dairy farmer, Invercargill, March 29, 2021). This same informant went on to describe the high levels of debt some farmers have acquired over the years, and how this impacts their capacity to overcome and manage adverse changes: *‘They mortgage their soul, but then they get a couple of tough years’* (see also Fennell et al., 2016 for related example on droughts and farm debt in Australia). Indeed, high levels of debt, combined with regulatory uncertainty and the heavy workload were all frequently mooted as factors that impact farmers’ mental health and wellbeing, and in turn, influence their willingness and ability to engage in environmental and climate change activities (pers. comm. male dairy farmer, Lumsden, 19/05/21).

Overall, farmers explained that they weigh the environmental and economic performance of their farming system in decisions to implement adaptive strategies, with many farmers viewing permanent wintering facilities as a pathway to guarantee the longevity of dairying in the cool and wet south, despite their potential risks. Indeed, the dairy industry, particularly Fonterra, promotes intensification and a reliance on technology as a solution to overcoming increased environmental regulation (Burton and Wilson, 2012). However, the high costs associated with some technological solutions (such as wintering facilities) makes them more accessible and appealing to larger farms with financial means, while potentially increasing the financial strain on other farmers. Below, we describe how climate change adaptation practices are perceived as fair and inclusive, and how these perceptions influence the uptake of adaptation practices.

4.3. Real or perceived perceptions of fairness among farmers

Fairness, whether it is real or perceived, significantly impacts how adaptation decisions are made and gain legitimacy (Adger, 2016). Adger et al. (2009, p. 512) argues that climate change interventions are more likely to be accepted locally if they are interpreted by those involved as ‘fair, transparent and inclusive’, leading to ‘positive and fair outcomes for the individuals and groups involved’.

Results from interviews revealed local anxieties that future climate change legislation, whether focused on adaptation or mitigation, may unfairly disadvantage the present and future generations of farmers. Various farmers commented that they are more concerned by the legislative response to climate change than the physical impacts of climate change itself. Similarly, Cooper and Rosin (2014) describe the contestation of Aotearoa-New Zealand’s emission trading scheme among farmers and their valorisation of food production. Indeed, during fieldwork various farmers noted that it is unfair to tax what they view as essential food producing farm work, in the same manner as tourism and transport. We also found that the loss of the family farm or opportunities for the next generation of farmers to enter the industry through ‘regulatory burden’ is one intangible impact of climate change (see Tschakert et al., 2017 on intangible losses) that is seen as *‘not fair for the next lot of generation of farmers’* (pers. comm. male dairy farmer, Brydone, 16/03/21)⁹. One farmer working towards land ownership quoted: *‘Eventually, we’d like to buy into the family farm, organise succession, that’s huge just trying to do that and thinking is it worthwhile doing it with all these changes?’* (pers. comm. male dairy farmer, Colac Bay, 30/03/21).

Increasing regulations, and the capital investments needed to overcome them (such as wintering facilities), are a barrier to adaptation for some farmers. While most farmers acknowledged that a wintering barn would improve their environmental outcomes, as one farmer stated: *‘the*

cost would cripple us, it’s just not an option for a lot of farmers’ (pers. comm. female dairy farmer, Seawards Down, 15/03/21). These findings suggest that larger corporate owned farms – with greater access to financial resources – may have an advantage in adapting to both the physical and legislative impacts of climate change, over smaller scale family or new entrant farms, at least in the near term. Furthermore, these regulations and the associated administrative work are also seen to be pushing older farmers out of the industry, as one informant nearing retirement commented: *‘I’ve been brought up not to do paperwork and I’m not computer savvy. So, it’s a bit of a struggle for us old blokes isn’t it?’* (pers. comm. male dairy farmer, New Ferry, 22/04/21). Yet, while younger dairy farmers may be more open to the necessity of greater environmental controls, as also described by Jay and Morad (2007), they may also lack the financial resources needed to implement them successfully.

Furthermore, it is important to note that while many farmers assume climate change will lead to greater regulation, there is still some optimism within the industry. Indeed, the younger informants we spoke with generally had a more optimistic view of the future and their capacity to adapt to change. One younger farmer commented that: *‘I think people in our generation and younger kind of get it a bit, don’t we? So I guess if you kind of get it, it makes it easy to adapt’* (pers. comm. male dairy farmer, Clinton, 08/03/21). Interestingly, each of the husband-wife couples we interviewed, who were jointly involved in daily farm operations, ran lower input systems and were experimenting with environmental activities, such as alternate crop varieties, regenerative farming techniques or riparian plantings. These findings signal that renegotiated gender roles and the more equal representation of women in farming, may play an important role in transformational adaptation (see Burton et al., 2020 for a discussion of the ‘gendered good farmer’), and this is a promising area for future research.

5. Transformational adaptation across different dairy farmer identities

As outlined in the introduction, transformational climate change adaptation is concerned with the pursuit of locally ‘just’ solutions (Adger, 2016; Forsyth, 2014), that address the structure and root causes of present-day vulnerabilities (Bohle et al., 1994; O’Brien, 2012; Pelling, 2011; Ribot, 2011), while forwarding novel or path-shifting modes of agriculture (Abel et al., 2016; Fedele et al., 2019). By investigating locally embedded experience, values and perceptions of fairness across different farmer identities, we highlight four non-exhaustive, sometimes overlapping, yet representative adaptive pathways that were discussed amongst farmers. Below, we describe how each approach contributes to, or constraints, transformational change. These include the pursuit of on-farm infrastructure and intensification, low input or regenerative farming techniques, continuing as is, and for some, potentially even exiting the industry (Table 2).

Investing in on-farm infrastructure and intensifying production is a pathway pursued by more financially capable farmers as they respond to increasing regulation, climatic change and other livelihood risks. As discussed above, investing in an expensive wintering facility is seen as a guaranteed way to overcome severe wet weather events now and in the near future. Yet, this pathway is generally reserved for those farmers who own more land, run a higher stocking rate and have a greater borrowing capacity. Furthermore, once committed to, wintering facilities often facilitate further intensification, as they require a higher stocking rate, greater dependency on imported feed and the need to continue milk production over the winter months to recover costs. While this capital investment may overcome the impact of climatic events in the near term, we caution that it may also encourage path dependency in the longer-term, leading to a ‘double exposure’ situation (Burton and Peoples, 2014), or ‘lock-in trap’ (Cradock-Henry, 2021) where farms are increasingly left exposed to both market forces and climatic events.

Intensification – accompanied by high levels of debt and input costs – can create a ‘make or break’ situation during extreme events (Fletcher

⁹ However, this intergenerational understanding of fairness and farm succession only extends back European settlement and overlooks legitimate Māori claims to land.

Table 2

Potential adaptation pathways pursued by different farmer groups in the lower South Island and how they enable or create barriers to transformational change (Note: the pathways are not exhaustive and farmers may draw on multiple pathways at different times. The list does not cover large corporate owned farms).

Adaptation pathway	Farmers' identity	Barriers to transformational change	Enablers of transformational change
Smaller-scale, less intensive or regenerative farming, sometimes with diversification.	Predominantly younger, yet also some older more experienced farmers, often accompanied by equal gender or family member participation in farm operations.	Limited financial means to pursue larger-scale farm systems change.	Less intensive farming, which improves soil condition, spreads financial risk, and reduces dependency on external inputs. Greater levels of optimism and regulations are viewed more fairly.
Capital infrastructure investment and intensification.	Young or old farmers, with medium- to large- land holdings.	Encourages 'path dependency', increases reliance on imported feed, and constrains options for alternative land use practices.	Addresses soil damage caused by present and future climatic events.
Continue as is, relying on past skills and knowledge.	Older experienced family farmers or those with limited financial resources.	Obscures opportunity to shift trajectory.	Knowledge and past experience of climatic events.
Exit the industry.	Farmers struggling to manage climatic stresses and increasing regulation, particularly sharemilkers and farm managers.	Limited resources to overcome livelihood shocks and stresses associated with dairying.	Provides opportunity to exit the industry and pursue alternate livelihoods (if not constrained by high levels of debt).

and Knuttila, 2016), or can even lead to poor mental health outcomes (Botha and White, 2013). Furthermore, this approach potentially limits future adaptive capacity in cases where excessive resources have been funnelled towards maintaining one farm system, at the expense of future options (Beilin et al., 2012). Indeed, one farmer who invested in a wintering facility eight years ago explained that their current system wouldn't be economically sustainable with fewer cow numbers and that their existing infrastructure investment makes it increasingly difficult (yet not impossible) to shift away from dairying (pers. comm. male farmer, Clydevale, March 23, 2021). The risks associated with intensifying too far was further articulated by another farmer with: *'We've done that kind of farming where the farm's above carrying capacity. You've got to sort of keep an eye on things because you can spiral out of control pretty quick'* (pers. comm. female farmer, Waimumu, May 19, 2021).

As a result, some farmers we interviewed have embarked on an alternate approach to overcome livelihood pressures (climate induced or otherwise), and are pursuing smaller scale, less intensive or regenerative farming techniques. This pathway requires fewer external inputs, is often less damaging to the local environment, and has greater scope for the integration of alternate livelihood diversification strategies (i.e. oats or vegetable cultivation, bees, eco-tourism). One young couple who run a lower input system explained: *'we were at a meeting last night and someone's like, why aren't you guys milking more cows? ... But we're happy doing what we're doing, it works for us. We don't want to milk a million cows, we're quite happy with our 550 it's enough'* (pers. comm. male farmer,

Waimumu, May 19, 2021). Interestingly, this demographic appeared more open to discussions about, or were even already actively engaged in, planning for climate change impacts. For example, one younger regenerative farmer who is currently experimenting with different grass species that can withstand varying levels of drought or wet weather noted that: *'It's going to affect us and affect our business, so you've got to have some interest in it [climate change]. It'll continue to be something we're going to have to have to farm for I suppose and adapt to it'* (pers. comm. male farmer, Edendale, May 18, 2021).

As mentioned above, we also found that each of the younger generation husband-wife teams we interviewed who were jointly involved in farm operations were also pursuing a less intensive pathway and experimenting with different crop varieties and native tree plantings. While the role of gender participation in climate change adaptation activities was beyond the scope of our initial research design, we support recent calls for more contextual studies of rural adaptation that focus on the role of gender relations and ideologies in the division of labour, uptake of environmental initiatives, decision making, and coping mechanisms, particularly in high-income agricultural settings such as Aotearoa-New Zealand (for some useful examples see Fletcher and Knuttila, 2016; Fletcher and Reed, 2022).

During fieldwork we encountered another group, notably older farmers or those with fewer livelihood alternatives, who prioritise 'a business as usual' approach, drawing on past experiences and knowledge to overcome future climatic or other livelihood changes. These farmers exemplify the statement that: *'as a farmer you've just got to learn to cope'* (pers. comm. male dairy farmer, Clydevale, 20/07/21). As described above, wintering barns do not always align with the value some of these farmers place on open country dairying, and their capacity for adaptation draws on extensive experience overcoming adverse weather events and other livelihood stresses, including periods of drought or floods and overseeing the conversion from sheep to dairying, in the past (Dynes et al., 2010; Kenny, 2010; Sumane et al., 2018). Adaptation is more likely to follow a series of steady incremental, rather than transformational steps (Vermeulen et al., 2018), embodying a 'wait and see' approach, albeit still remaining open to the possibility of farm systems change.

Exit from the industry represents a final pathway, particularly for some sharemilkers or farm managers, sometimes on flood prone land, who are exhausted by climatic events and increasing levels of regulatory burden. Unlike some land owners burdened with high levels of debt, this group may still have the option to leave the industry. This was evidenced in the multiple farms that were for sale in areas that have been repeatedly inundated by recent floods and was raised by the younger farmers we interviewed who were currently deciding whether it was worth committing to dairying in the long-term (and working up the 'dairy ladder') given the industry's regulatory uncertainties.

Overall, during interviews we found that many farmers are presently hesitant to pursue more radical or transformative pathways of change (for example, investing in alternative farm systems), due to limited financial resources, debt, uncertainty around future environmental regulations, and market demands. As one couple quoted when asked if they will always be dairy farmers: *'We owe too much money not to be'* (pers. comm. female dairy farmer, Tapanui, 27/07/21). Yet, while the pathways outlined above are useful in elucidating the different adaptive strategies currently used by dairy farmers, defining what transformation should look like in this highly productive, yet flood prone landscape, remains unclear. We suggest that future work should engage with the broader social-ecological impacts of the industry (Bojovic and McGregor, 2022), issues of land redistribution including Māori claims over productive land (Campbell, 2021; Wynyard, 2019), while remaining cognisant of the contextual and structural constraints, including gender relations, that shape the adaptive pathways of the lower South Island's dairy farmers.

6. Conclusions and implications of study

Intersectional analyses grounded in the political economy and embedded in local contexts can help disentangle barriers and enablers to transformational and equitable climate change adaptation. Our study shows that the vulnerability and adaptive capacity of lower South Island dairy farmers is socially and economically differentiated, and influenced by experience, values and perceptions of fairness. We found that some experiences of climate change – such as taking a cautious ‘wait and see’ approach towards acting on climate projections, frustration at regulatory burden, and the valorisation of farming – were consistent across many different farmer identities. However, clear distinctions in vulnerability, notions of fairness, and adaptive capacity were observed across farmers of different ages, financial status, levels of on-farm intensification and involvement of family members in farm operations. For example, older farmers appeared to be most impacted by regulatory burdens, while younger farmers or those with fewer financial means were sometimes left working land that is flood prone or at higher risk of pugging during wet weather events. These results contain two important lessons for the development of contextualised and locally relevant climate change adaptation programs.

First, as not all dairy farmers are equally able or prepared to respond to the physical and legislative impacts of climate change, there is greater scope to tailor adaptation activities to the needs of different farming groups or identities. While most of the farmers we spoke with self-identified as being adaptable to change, there may be some limits to this adaptation (Adger et al., 2009), for example, those carrying large amounts of debt or experienced sharemilkers and older landowners who are increasingly deterred by the influx of new regulations. While capital investments (such as a wintering facility) and intensification can overcome some immediate environmental and climatic concerns, this pathway is extremely costly (making it off-limits to many younger farmers and lower input systems), and risks introducing new livelihood vulnerabilities and path dependencies. Notably, the younger farming generation – particularly those with lower input system and more equal gender or family participation in farm operations – appeared more optimistic and were more likely to view future regulations associated with climate change more fairly. If geared with regulatory certainty, knowledge and adequate resources, we suggest this group could be in a stronger position to proactively implement more transformational changes.

Second, the study demonstrates that fairness, both real and perceived, can create a barrier to the uptake of adaptation decisions. While the climate justice literature has rightly focused on issues of fairness and conflict in developing nations, our study demonstrates that there are also diverse views of fairness in more developed and larger-scale agricultural contexts that have the potential to generate conflict and derail adaptation processes. Lower South Island dairy farmers valorise farming lifestyles and food production, often above environmental and GHG reforms (see also Cooper and Rosin, 2014). Yet, this valorisation of farming is sometimes at odds with government regulations, creating space for conflict to emerge.¹⁰ While the rapidly changing nature of Aotearoa-New Zealand’s farming landscape suggests that some level of conflict may be irreconcilable, we suggest there is still space for greater contextualised engagement with farming communities that recognises different farmer identities and allows adaptation decisions to be built from the ground up,¹¹ without undermining the necessity for

¹⁰ An example of conflict is found in the current farmer protest movement, Groundswell, see <https://www.odt.co.nz/rural-life/rural-events/%E2%80%9898enough-enough%E2%80%9999>.

¹¹ A promising example is found in the Pomahaka Water Care Group, a community based farming organisation that monitor local water quality, conducts riparian plantings, and mediates cases of non-compliance (see <http://pv.cg.co.nz/>).

significant environmental and GHG reforms.

Yet, notions of fairness can and should also extend beyond the farm gate to consider who benefits most from the dairy industry and what has been unfairly lost (both environmentally and particularly for the indigenous Māori, culturally) in the process. We forward that realising the just and transformational adaptation of Aotearoa-New Zealand’s dairy industry hinges on developing a shared understanding and acknowledgement between the dairy industry and wider society, of the complex historical, social, economic, cultural and environmental drivers of the industry.

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Declaration of competing interest

None.

Data availability

The authors do not have permission to share data.

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