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Publication Date
2021

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA
SANTA CRUZ

**CATTLE ARE FOR FIGHTING OVER:
CALIFORNIA DAIRY IN THE AGE OF SUSTAINABILITY**

A dissertation submitted in partial satisfaction
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ENVIRONMENTAL STUDIES

by

Rachel Marie Shellabarger

June 2021

The Dissertation of Rachel Marie
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Abstract

Cattle Are for Fighting Over:
California Dairy in the Age of Sustainability

Rachel Marie Shellabarger

In environmental circles there are frequent calls to reduce livestock agriculture as a means of improving sustainability of the food system. These appeals are placed upon—and indeed, frequently enflame—an already contentious relationship between environmental communities and livestock industry actors. In this dissertation I peel back some of the layers of this conflict via a focus on California dairy production. California dairy is an important player in recent state efforts to mitigate climate change, so the tense relationship between this livestock agriculture sector and environmental initiatives warrants attention. Understanding the variety of forces at play in the ongoing tensions can help to identify new strategies for mitigating livestock's environmental impacts. In particular, this research brings attention to social, political, and economic drivers of surplus production as important components of the conflict, underscoring the need for supply management as a solution to both environmental and economic concerns in the industry. It also highlights the potential for new governance policy arrangements to circumnavigate some of the existing tension and implement new environmental initiatives to mitigate climate change.

Acknowledgments

I am grateful to many communities of people for facilitating this research and supporting me through its conclusion. I must first acknowledge the host of California dairy producers, processors, vendors, regulators, and other affiliates who trusted me enough to share their stories, especially given the context described in this dissertation. I am indebted to the research community who pushed me to do better work and supported me when I needed a hug, particularly my fellow graduate students who have been such amazing friends and colleagues. Carol, Daniel, and Madeleine, you have been such impressive examples for me of what faculty can be, and I will be forever grateful for your support. Lastly gratitude goes to my family, the ones who inevitably shoulder so many of the invisible costs of graduate school due to late nights and a cranky loved one. Thank you all.

Introduction

Environmental science literature frames livestock agriculture as a problematic land use, spurring a research agenda focused on measuring livestock production's environmental impacts and identifying technical solutions (Herrero et al., 2015). Substantial effort is spent calculating greenhouse gas emissions from livestock industries and using that to comment on overall industry sustainability (Gerber et al., 2013; Institute for Agriculture & Trade Policy & GRAIN, 2018; Steinfeld et al., 2006), despite the inappropriate nature of using single metrics to evaluate the sustainability of complex agroecosystems (Ayantunde et al., 2011).

In contrast to the environmental discussions of livestock production which often focus on one or two overall metrics, research focused on farmer innovation adoption has acknowledged that sociocultural, political economic, and biophysical factors collectively influence farmer decisions to adopt sustainable practices (Dumont et al., 2013; Farley et al., 2010; Funes-Monzote et al., 2009; Herrero et al., 2015). Current commodity prices and input costs, policy incentives, labor trends, natural resource bases and landscape processes, sociocultural context, network ties, and historical circumstances exist and interact to assert influence on farmer actions (Richardson et al., 2007; Rieple & Snijders, 2018). The recognition of complex dynamics which shape production decisions represents a real contrast with the way livestock's environmental impact is presented to the broader public.

The disparity between these two conceptions of livestock production mirrors on-the-ground circumstances in which those conversing about livestock agriculture frequently talk past one another with wildly different interpretations (Fazio, 2021). Environmental communities and livestock producers often have a tense relationship: environmental groups can be seen to portray livestock as not only a climate villain but a menace to human health (see., e.g., National League of Cities, 2018) and livestock producers decry the ignorance of urban populations which they feel target rural producers (Jordan & Sullivan, 2017). Emotionally-laden rhetoric often ignores complex political economic, sociocultural, and environmental influences that have heavily shaped the U.S. food system today and bear on attempts to build a more sustainable agriculture.

Given the pressing weight of sustainability challenges like climate change and the important role of livestock agriculture in addressing sustainability concerns (Smith et al., 2008; Sumner, 2014), there is an urgent need to improve upon the current situation. The search for greater sustainability in livestock production requires balancing multiple, interacting social and environmental factors that exist at different scales, making it a textbook wicked problem (Bouma et al., 2011; Levin et al., 2012; Peterson, 2013). Simplified, one-size-fits-all (or one-size-fits-most) solutions cannot provide adequate solutions for wicked problems (Shortle & Horan, 2017).

How can we move forward given the current relationship between livestock and environmental communities, and the wicked nature of the problem? To begin to address this question the following dissertation utilizes the case of California dairy production. California dairy production in many ways reflects the tense relationship between environmental communities and livestock industries (see, e.g., Cagle, 2016), and also contends with the same challenges that are often recognized as hurdles to more sustainable agriculture broadly: cost-price squeezes, increasing consolidation and intensification, volatility attached to globalized markets, labor challenges, and climate change concerns (Clapp, 2016; Genoways, 2017; Guthman, 2004; Harrison et al., 2009; Harrison & Lloyd, 2012; Hendrickson et al., 2013; Howard, 2016). At the same time the dairy industry broadly, and California dairy in particular, reflects unique characteristics that can shed light on opportunities for sustainable agriculture efforts: dairy presents particularly high climate change concerns compared with other livestock industries (Sumner, 2014), dairy has trailed other livestock industries in the degree of contract farming (Ashwood et al., 2014; Hendrickson et al., 2013; Hinrichs & Welsh, 2003; Thu, 2009), dairy cooperatives and milk marketing orders continue elements of supply management which have largely been removed from U.S. agriculture (Graddy-Lovelace & Diamond, 2017), and California dairy specifically reflects interplay between distinct production environments including rural-exurban and conventional-organic (Sneeringer, 2011).

In this dissertation I work from several key questions. What does California dairy look like today, and how did it get to this point? How can this understanding inform future steps towards a more sustainable food system? I examine the interplay between political economic, sociocultural, and biophysical factors—as well as different regional trends—to collectively shape the current dairy production landscape. I look at what current conditions mean for the lived experience of dairy producers, and how we can better understand and utilize the diverse contexts of California dairy producers to meet future sustainability goals via public policy. This work centers producers as complex actors in dynamic circumstances (Bell, 2010; Hassanein, 1999; Natcher et al., 2005; Soubry et al., 2020), and recognizes social processes as time- and place-bound (Gilbert & Wehr, 2003; Wells, 1996). It also draws on sustainability transitions literature to consider how systems and industries can shift to more sustainable forms and paradigms (Avelino & Wittmayer, 2016; Elzen et al., 2004; Geels & Schot, 2007; Lawhon & Murphy, 2012; Runhaar et al., 2020). This dissertation builds from the literature on urban-rural dynamics in U.S. agriculture, research into environmental impacts of livestock agriculture, and public policy approaches to regulating U.S. agriculture. Bringing these themes together in the study of California dairy responds to calls for more political ecology work on food systems in the Global North (Galt, 2013) and the need for regional foci (Walker, 2003).

In this work I join a growing set of voices—academic and otherwise—drawing attention to the need for supply management to address both environmental and economic crises facing U.S. agriculture today (*Disparity to Parity*, 2021; Wisconsin Farmers Union, 2020). This policy path could provide positive synergies for producers and consumers alike, but it will be an uphill battle to enact not least because of the consolidated power entrenched in our agrifood system (Benson & Faminow, 1986; Hendrickson et al., 2013; Howard, 2016). The challenges of climate change demand we transition to more sustainable forms of production, and that means rejecting a food system that drives producers to squeeze increasing morsels of food from the land for decreasing pennies (Cochrane, 1979; Ward, 1993). As we find ways to shift to more sustainable agriculture, our approaches must be informed by the voices of producers and the historical contexts that created their circumstances. This dissertation contributes new data to that effort.

Positionality Statement

The context and research described here incorporates difficult social realities, particularly regarding the strained relationship between livestock producers and environmental groups. Because I conducted fieldwork myself, my positionality and interaction with informants became a part of the research (Lincoln & Guba, 1985). My position as a researcher, and the knowledge and experience that I brought to the research, therefore require some explanation.

My experience as a former dairy producer gives me insight into and understanding of dairy producing communities. Livestock producers can be a difficult population to access, often stemming from producer mistrust of the public that is most starkly exhibited outside of California in so-called "ag gag laws" (Kingery, 2012). As a result of access difficulties, many livestock producers' perspectives are omitted from environmental research, depriving sustainable agriculture efforts of important insights from these producers. My background and capacity to relate to dairy farmers bolstered my ability to develop the relationships that were required to examine the landscape of dairy production given this tension.

In addition, my academic background in natural resource management allowed me to facilitate transdisciplinary dialogue which conveys farmer realities to researchers focused on environmental concerns. I have experience doing this sort of boundary crossing, as my previous master's research investigated a legal conflict between a federal land management agency and a humanitarian volunteer group (Shellabarger, Peterson, & Sills, 2012; Shellabarger, Peterson, Sills, et al., 2012). I collaborated with both groups to better understand their realities in the complex realm of the U.S.-Mexico borderlands, and maintained productive relationships with both sides even on the day of the court trial. I therefore approached this research hoping to facilitate the sort of dialogic relationship that is necessary to make sustainable agriculture more feasible (Bell, 2010).

My characteristics as an individual and a researcher allowed me to carry out this work, while also affecting the environments in which I observed and interacted. My presence as an individual embodying multiple seemingly disparate identities—environmental researcher, livestock producer—was an important component of the more open dialogue that I hope to foster between environmental communities and livestock producers. In almost every fieldwork setting in which I participated, dairy industry actors were surprised to see someone from my institution who seemed genuinely interested in learning about their realities. Dairy industry actors tend to view the Santa Cruz area as a hotbed of aggressive environmental activism, particularly what is often described as the “vegan agenda”. While I sought to make dairy producers’ complex realities more salient to environmental communities, my presence amongst dairy industry communities also communicated something about the diversity of environmental community actors: that the unified image of extreme environmental activism (embodied by the oft-used phrase, “vegan agenda”) cannot be universally, uniformly applied to environmental communities.

The experience and characteristics that I brought to this research allowed me to overcome some of the trust barriers that often prevent dairy industry actors from speaking to environmental researchers. At the same time, they presented potential for bias on my part. Additional potential for bias came from informants themselves, who likely catered their statements to me—perhaps sometimes intentionally, sometimes unknowingly—in light of the existing tension between livestock producers and environmental communities. For each of these areas of potential bias—on my part as well as that of industry actors—triangulation of data and corroboration from multiple source types was an important check on data validity.

The power relations present in interview settings for this research were varied and complex, especially in the emphasis on me as an individual. Different producers and industry actors alternatively suggested that I could be a potential public relations nightmare or a blessing, a means of either reigning in an environmental regulatory beast or communicating policy goals to stakeholders who were out of the loop. In addition to their hopes for me, I could not help but be aware that each interviewee's perception of me would either open or shut research avenues, as well as confirm or contest their perceptions of my institution and profession. I did my best as a researcher to pay attention to the ways that I presented and considered myself in each context, and to be aware of the ways others acted in response. Detailed field notes and reflexive analysis helped me understand how social norms and behaviors affected the data I collected, and thus steered my analysis to critically examine what I might have otherwise taken at face value.

Chapter 1. Efficiency is not enough: Dairy and the path to sustainability

Introduction

Environmental rhetoric regarding livestock agriculture often centers around select global statistics. Frequently it is the Food and Agriculture Organization of the United Nations' (FAO) conclusion from the report *Livestock's Long Shadow* (Steinfeld et al., 2006) that livestock are responsible for 18% of global anthropogenic greenhouse gas (GHG) emissions. Sometimes it is the revised statistic that livestock contributes 14.5% of global anthropogenic emissions, from the report *Tackling Climate Change Through Livestock* (Gerber et al., 2013). Other times it may be the relative description that the top 20 meat and dairy companies combined emit more GHG emissions than countries like Germany, Canada, or Australia (Institute for Agriculture & Trade Policy & GRAIN, 2018). Whatever statistic is used, the environmental lens on livestock agriculture often focuses on a few simplified depictions.

This narrative about livestock agriculture glosses over the complexity and nuance inherent to livestock production systems (Deutsch et al., 2010; Herrero et al., 2013; Seó et al., 2017). By relegating discussion of livestock's environmental impacts to one or two global values, we as a discipline ignore the importance of biophysical and socioeconomic context that is frequently acknowledged in work on agro-ecosystems (Soussana et al., 2010; Wolf et al., 2011), conservation projects (Barrett et al., 2001; Calvo-Alvarado et al., 2009), and social movements (Rosset & Martínez-Torres, 2012). This consideration needs to extend more to the literature on livestock and the environment.

Here I look at the literature on livestock's environmental footprint with a particular focus on dairy production systems, a form of livestock agriculture that is sometimes included in eco-friendly diet proposals (Peters et al., 2016; van Zanten et al., 2016) in part because milk is produced with lower emissions intensities than some meat products (Herrero et al., 2013). I start with an overview of the literature on dairy's environmental impact, where it is clear that there are two positions from which authors write: either critiquing dairy for its environmental impacts, or defending dairy for its efficiency improvements. I then discuss how the common means of measuring impacts—that is, impacts per unit product—can reinforce problematic relationships in the current socioeconomic context. I conclude by suggesting that the literature's current emphases on efficiency, which is made with the laudable goal to reduce environmental impacts, must not be separated from realities of market oversupply and food waste. Current efforts to establish supply management in the dairy industry present an important opportunity to capitalize on efficiency gains and to improve environmental performance, while also potentially preserving remaining small- and mid-sized farms.

Literature Review

The literature surrounding livestock agriculture's environmental impact—and that of dairy in particular—mirrors the ongoing tensions between producers and environmental communities. One sector of the literature critiques dairy's environmental impact, whether focused on greenhouse gas emissions, nutrient pollution, or overall environmental impact. Some research in this vein critiques intensive systems and suggests alternative practices for improved production, while other research focuses on reduced livestock agriculture overall as the main mitigation strategy. A second large sector of the literature responds to these critiques and largely focuses on efficiency concepts to craft a rebuttal. This research often traces the improvement in environmental impacts per kg milk—specifically Energy-Corrected Milk (ECM) or Fat- and Protein-Corrected Milk (FPCM)—throughout time to argue that today's systems are less environmentally intensive than past operations and that further intensification will continue to improve the environmental performance of production. These two veins of research are presented in summary below; first the literature that critiques dairy's current environmental footprint, and then the literature that defends dairy from a focus on efficiency. Then in the following section I discuss the ramifications of the common metric used in both areas of research: impacts per unit product (kg milk).

Critiquing (and reconstructing) dairy production

Greenhouse gas emissions

A commonly cited statistic about the greenhouse gas emissions from the dairy industry is the conclusion from the 2010 FAO report (Food and Agriculture Organization, 2010) that global dairy production, processing, and transportation—including meat from dairy animals— contributes 4.0 percent [±26 percent] of total anthropogenic GHG emissions. Because dairy operations produce not just milk but also meat from culled animals, this statistic identifies an important sticking point with research on dairy's environmental impact: how to allocate environmental impacts between meat and milk co-products, if environmental impacts are to be assigned to specific commodities. We will return to the discussion of impacts being assigned to units of commodity in the Discussion, but for now it is sufficient to point out that all studies discussed here use an established form of allocation—assigning ratios to milk and meat products based on economics of the operation, mass of the animals/products, or energy intake—to determine the environmental impacts associated with dairy products (see, e.g., explanation in Thoma, Popp, Shonnard, et al., 2013)

There is wide agreement among scholars that the production stage (discussed as farm level or farm gate) creates the largest proportion of GHGs in the life cycle of dairy products (Berlin, 2002; Castanheira et al., 2010; Djekic et al., 2014). Thoma et al. (2013) identify the farm gate contribution for U.S. dairy operations as 72-75% of the fluid milk supply chain GHGs, while the FAO cites a global average of 93% that reduces to 78-83% for North America, Western Europe and Oceania (Gerber et al., 2010).

Manure storage is a major concern for dairy emissions (Amon et al., 2006; Guerci, Knudsen, et al., 2013; Thoma, Popp, Nutter, et al., 2013), particularly for arid regions like California where manure management contributes more GHG emissions than feed or enteric fermentation (Thoma, Popp, Shonnard, et al., 2013). Emissions from liquid manure slurry are a concern, and the potential for slurry additives and treatments to reduce overall GHGs seems mixed (see, e.g., Berg et al., 2006; Clemens et al., 2006; Yamulki, 2006). Covering manure storage and flaring the biogas (methane and carbon dioxide) decreases the carbon footprint (Belflower et al., 2012) by as much as 39% (Rotz et al., 2010). Anaerobic digestion of manure slurry—in which slurry is broken down and converted into methane gas in a contained anaerobic environment, and then used as biogas—is promoted in the literature as a "win-win" (Monteny et al., 2006), particularly for intensive systems where the fraction of methane from manure storage can be 15-20% (Gerber et al., 2010). Anaerobic digestion curbs environmental GHG emissions from manure slurry (Amon et al., 2006; Battini et al., 2014; Belflower et al., 2012) as much as 978-1776 kg CO_2 per livestock unit per year (Marañón et al., 2011), or -25 to -105% compared to model farms (Weiske et al., 2006). It is attractive because it uses output products for additional purposes, further recycling resources while reducing both on-farm CH_4 and N_2O (Weiske & Petersen, 2006): the biogas is used to produce heat and/or electricity for on-farm usage or potential commercial sale, and the digestate produced from the process can also be used as a fertilizer (Garnett et al., 2015; Monteny et al., 2006).

Enteric fermentation—that is, the methane produced during ruminant digestion—is frequently discussed alongside manure storage as the two most prominent contributors to dairy GHG emissions (Thoma, Popp, Shonnard, et al., 2013). Some research suggests enteric fermentation alone is the largest contributor (Gerber et al., 2011), with estimates as high as 49% of dairy emissions coming from enteric sources (Casey & Holden, 2005b). Other estimates combining enteric fermentation with manure storage suggest the two are responsible for more than 40% of fluid milk GHG emissions (Knapp et al., 2014, citing Thoma, Popp, Nutter, et al., 2013). Even with the range of estimates it is clear that reducing enteric fermentation would go a long way in mitigating dairy GHGs (Mc Geough et al., 2012). Thus innovations to disrupt methanogenesis and reduce enteric methane emissions have received much research attention, even if results have been somewhat mixed (see,.e.g., Feng & Kebreab, 2020; Lassey, 2008; Machmüller, 2006).

The production of cattle feed is cited as an important contributor to farm gate emissions (Thoma, Popp, Shonnard, et al., 2013), with fertilizer for livestock feed estimated to produce 41 million tons CO_2 per year (Koneswaran & Nierenberg, 2008; Steinfeld et al., 2006). Given this impact, researchers have suggested using cattle to consume human-inedible foods like grass (pasture) or crop by-products (almond hulls, citrus pulp) as a means of using local resources to reduce farm gate GHGs (Dumont et al., 2018; Food and Agriculture Organization, 2018; Pitesky et al., 2009; Stewart et al., 2009). In addition to the focus on diet and feed efficiency to control emissions, recent attention has turned to silage feed storage as an important source of volatile organic compounds like methane, moreso than previously thought (Place & Mitloehner, 2010).

Grazing cattle or feeding them crop by-products may lead to a reduction in farm gate emissions from feed (Rotz et al., 2009), but research attention is also turning to grassland on farms as an additional potential GHG savings via carbon sequestration on pasture and grazing land. Studies have integrated carbon sequestration to show reduced milk carbon footprints for dairies that pasture (Belflower et al., 2012; Gerber et al., 2010; Rotz et al., 2009; Seó et al., 2017) as well as similar meat production systems that utilize improved grazing (Conant et al., 2001, 2017; Soussana et al., 2010; Stanley et al., 2018). On the point of carbon sequestration specifically, scholars have noted that the Intergovernmental Panel on Climate Change (IPCC) methodology, particularly the commonly used Tier 1 factors, tends to underestimate the capacity of grazing lands for carbon sequestration (Viglizzo et al., 2019) and cannot capture impacts of interventions at the local scale (Crosson et al., 2011; Schils et al., 2005). These scholars caution against using macro-scale estimates to make broad statements about the capacity for on-farm grasslands to sequester carbon, because the capacity for carbon sequestration on grazing lands is site-specific and influenced by local contextual factors like management and climate (Soussana et al., 2010; Wolf et al., 2011). Indeed, in areas where wildfires are predicted to increase with climate change, grasslands present an especially valuable sequestration option because the carbon is stored underground and not released during a fire (Dass et al., 2018; Kerlin, 2018; Viglizzo et al., 2019).

Much of the research critiquing dairy GHGs suggests technological or management interventions, as outlined above. Other researchers suggest that even with these interventions, the only option forward is to reduce production and consumption of livestock products (Garnett et al., 2017; Havlík et al., 2013; Popp et al., 2010). Berners-Lee et al. (2012) estimate 22% (vegetarian) and 26% (vegan) potential GHG savings if United Kingdom residents switched from the average diet to vegetarian or vegan diets. And another subset of researchers identifies that no single strategy can bring GHG emissions to acceptable levels across the range of dairy operations. They stress the importance of being aware of tradeoffs (Knapp et al., 2014; Monteny et al., 2006; Scholefield et al., 2005), and suggest that some ideal combinations of strategies may produce synergistic effects (Beukes et al., 2010, 2011; Casey & Holden, 2005b).

Nutrient management

Research critiquing dairy on the basis of nutrient pollution focuses on intensification (particularly in terms of stocking rate), feed practices, and manure storage. Researchers often use different ways to categorize and analyze farm types, making it difficult to directly compare conclusions, though the general trend of the literature is toward suggesting lower stocking densities. In one study organic dairy farms had lower average N-surplus (though not statistically so), but greater ammonia emissions were traced to higher livestock density regardless of production type (Cederberg & Flysjö, 2004). Roberts, Leach, and Goldie (2007) also attributed increase in N output per hectare to stocking rate rather than milk yield or milk protein content, metrics which can be correlated with organic or conventional production but which are also influenced by numerous factors (Kristensen et al., 2005; Schwendel et al., 2015). In another study, pasture-based dairies were found to have lower phosphorous runoff but greater nitrate leaching (Belflower et al., 2012); yet Soder & Rotz (2001) found the opposite with regards to nitrate leaching for grazing dairy operations. Nielsen and Kristensen (2005) found that N and P surpluses were greater on conventional than organic dairies, even at the same number of livestock units per hectare. In another study acidification (SO_2 equivalents) and eutrophication (PO_4 equivalents) potentials were higher in intensive versus extensive or organic dairy operations, with similar trends following farm gate N and P balances (Haas et al., 2001).

Scholars using feed practices to investigate nutrient management tend to emphasize the importance of diet formulation and nutrient use efficiency. On many operations at least a portion of feed is imported from off-site—particularly because feeding concentrate supplements increases profitability (Soder & Rotz, 2001)—so nutrients excreted as waste lead to an excess of nutrients on-farm (Garnett et al., 2015). Dou et al. (2003) found consultants recommended higher P rations than necessary, leading to higher P excretion but not higher milk yields; the trend for excess P in diet formulations is backed up by other research, as well (Ebeling et al., 2002; Powell et al., 2002). This illustrates the heavy influence dairy consultants can have, particularly for large operations (Russell & Bewley, 2013). In regards to N, approximately 72% of nitrogen consumed by cattle is excreted as waste (Castillo et al., 2000; Jonker et al., 2002). Urinary N is the more important source of N pollution and strongly correlated with N intake, which may be controlled by keeping N intake below 400 g per day (Castillo et al., 2000; Kebreab et al., 2001); reducing crude protein concentration and degradability can also help reduce ammonia emissions (Kebreab et al., 2002; Powell & Rotz, 2015).

Research on manure storage and application can seem difficult to parse. In general, handling large amounts of manure (Belflower et al., 2012) and leaving manure uncollected in non-productive areas of the farm (Gourley et al., 2012) both increase potential for nutrient losses (Powell et al., 2005; Powell & Russelle, 2009). Where manure slurries are applied to cropland, careful application is important (Jarvis et al., 1996) as even a single day delay in incorporation can lead to losses of half the ammonia (Jokela & Meisinger, 2008). Composting manure that can be transported off site is a potentially beneficial option but it often comes at a cost for the producer (Osei et al., 2000).

Many other suggestions for improving nutrient management center around pasture management and organic conversion. For instance, research has suggested that white clover planted alongside perennial ryegrass can offset 200 kg N per ha per year in a pasture (Andrews et al., 2007), although the white clover may affect milk production (Jarvis et al., 1996). In general clover systems may be more efficient in terms of energy or GHGs, but not necessarily for nutrient losses (Ledgard et al., 2009). However, close management of grazing timing can have a substantial impact on nutrient losses (Kristensen et al., 2005) and reduce both N_2O and NO_3 as much as 40% in certain climates (de Klein et al., 2006). As with any agricultural practice, however, managing for a goal like soil N retention often means tradeoffs in another area (Chen et al., 2015). Organic conversion can reduce total N losses—specifically in eutrophication potential from reduced fertilizer application (de Boer, 2003)—but comes at either a cost to production or requires an increase in land area to maintain production levels (Dalgaard et al., 1998).

Overall environmental impact

Studies aggregating multiple metrics into an overall evaluation most commonly identified intensification (generally meaning the use of more inputs to get more product from each cow) as the driver of environmental impacts (Basset-Mens et al., 2009; Garnett et al., 2017; Penati et al., 2011; Steinfeld et al., 1997). While acknowledging that it is difficult to identify the most environmentally friendly way to produce milk, Bava et al. (2014) found that on a local scale the impacts per hectare positively correlated with intensification. Frequently, studies pointed to environmental impacts associated with feed crops as the factor that made the difference for intensified systems (Guerci, Knudsen, et al., 2013; O'Brien et al., 2012; Thomassen et al., 2008). Thus feed efficiency (Guerci, Bava, et al., 2013; Guerci, Knudsen, et al., 2013; Herrero et al., 2013; Thoma, Popp, Shonnard, et al., 2013) and feeding cattle human-inedible materials like forages and food by-products (Gill et al., 2010; Wilkinson, 2011) are important foci for minimizing the environmental impacts of livestock products, as measured per kg milk. This is a key point for dairy since feed efficiencies to produce animal protein are found to be 1.5-5 times higher for milk over ruminant meat (Herrero et al., 2013). Grazing is put forth as a strategy to reduce the overall environmental footprint of milk, with recognition that it requires more land use and that comes with a level of environmental impact (Arsenault et al., 2009; Basset-Mens et al., 2009; Peyraud et al., 2004).

As with the work on GHG emissions, many researchers point to the overall environmental impact of meat and dairy to suggest reducing overall livestock production and consumption (Eshel et al., 2014; Hedenus et al., 2014; Hoekstra, 2012; Metson et al., 2014; Niles et al., 2017; Stehfest et al., 2009). Conflict over these conclusions has played out in various circles, including academia. A number of scholars base their arguments on numbers from Eshel et al. (2014), numbers which Tichenor (2015) says fail to account for the interconnections between beef and dairy systems; though the authors say Tichenor's corrections fall within their bounds of uncertainty (Eshel et al., 2015). While this interaction regarding Eshel et al.'s conclusions is at one level a normal part of the scientific process, the interaction also illustrates the ever-present tension in the environmental literature on livestock agriculture.

Defending dairy production

The previously summarized literature presents critiques of livestock agriculture's environmental footprint, while also suggesting some opportunities for improvement. Most of the above work uses a similar metric to report environmental impacts: impacts per kg milk (usually Energy-Corrected Milk (ECM) or Fat- and Protein-Corrected Milk (FPCM)). The second group of literature we will discuss uses a historical lens on this metric to defend milk production's environmental standing and suggest that rather than being a problem, intensification can be a solution for sustainable dairy.

Greenhouse gas emissions

Overall agricultural intensification has led to higher yields which Burney et al. (2010) say has avoided emissions of as much as 161 gigatons carbon since 1961, even accounting for emissions of increased inputs like fertilizer. Capper's (2012) paper summarizes much of the argument for intensification as a GHG mitigation scenario, though focused specifically on beef: intensive production (feedlot finished with growth-enhancing technology) requires the least overall resources and fewest animals to produce a unit of beef, thus the carbon footprint per unit beef from this production system is lower than non-feedlot systems or those without growth-enhancing technology. Researchers identify that on a national and global scale, intensification can help GHG emissions reductions (Baker et al., 2013; Knapp et al., 2014; Steinfeld et al., 2006). Capper et al.'s (2009) report supports this idea with the conclusion that U.S. dairy production in 2007 had a carbon footprint that was 37% of the carbon footprint of milk in 1944. In a similar study with updated methods comparing 2007 with 2017, Capper and Cady (2020) found that GHG emissions per million metric ton milk in 2017 were 80.8% of the equivalent volume of milk in 2007, though because of increased milk production total GHG emissions increased by 1%. Comparing emissions in 1964 to those in 2014, Naranjo et al. (2020) found that modern California dairies emitted 45-46.9% less CO_2 equivalents per kg energy- and protein-corrected milk.

One of the key arguments for dairy systems specifically is that the types of GHGs change as productivity increases—proportions of methane and nitrous oxide decrease while carbon dioxide increases, reflecting the various inputs of fossil fuels (Gerber et al., 2011). Gerber et al. (2011) give four reasons for this trend: animal diets in intensive systems contain more concentrates and less forage which means lower methane production (Bava et al., 2014; Pitesky et al., 2009), at high levels of production the emissions associated with maintenance and replacement are spread over larger volumes of milk (Steinfeld et al., 2006), nitrogen use efficiency increases for animals in intensive systems so N_2O emissions per kg milk is reduced, and the bulk of emissions come from production (particularly enteric fermentation) so intensification does not lead to more emissions further down the supply chain. This trend holds strongest for lower productivity systems, meaning those under 6000 kg FPCM per cow per year, but particularly under 2000 kg FPCM per cow per year (Gerber et al., 2011); the average milk yield per cow per year in North America is over 8900 kg before being corrected (Gerber et al., 2010). Even for scholars that describe a need to reduce livestock agriculture, intensification is sometimes described as a way to make the inevitable growth in livestock agriculture "a little less bad" (Garnett et al., 2017).

Another focus for reducing dairy GHGs is genetics: selecting for more efficient feed use in cattle can reduce the amount of synthetic fertilizers used for on-farm production as well as the use of concentrate feed, thus reducing the overall GHG emissions (Bell et al., 2011; Henriksson et al., 2011). In cheese production, swapping out Holsteins for Jerseys (which yield a higher milk nutrient density) reduced the carbon footprint (Capper & Cady, 2012). Another consideration is fertility levels, since up to 27% of methane is released by herd replacements, so improving fertility levels could reduce methane emissions by 10-24% depending on the level of improvement (Garnsworthy, 2004). Any selection for one of these traits will likely have impacts for other aspects of dairy production systems—such as cull rates which influence the beef market—so the impacts of such herd dynamics changes could still affect overall estimates (Lovett et al., 2006).

Nutrient management

As noted above in Gerber et al. (2011), nitrogen use efficiency in cattle tends to improve with intensified operations (Jonker et al., 2002), so that less N is excreted from each animal. Capper and Cady's (2020) comparison of 2007 and 2017 data may illustrate this trend, as dairies in 2017 excreted 82.5% of the N and 85.7% of the P levels per million metric ton compared with 2007. Additionally, fine-tuning protein supplementation led to a reduction in volatile N loss by 13-34 kg/ha, and a reduction in N leaching by 1 kg/ha (Rotz et al., 1999). If fertility levels restore to 1995 levels or even improve beyond that, ammonia emissions could improve by 9-17% (Garnsworthy, 2004). Genetics and species selection can also improve nutrient management. Capper & Cady (2012) found that use of Jerseys instead of Holsteins for cheese production reduced N and P excretions.

Overall environmental impact

Given the above, some researchers who are focused on the overall environmental impact of dairy identify intensification as the path forward (Capper, 2014; Nguyen et al., 2013; Thomassen et al., 2009). They emphasize that less intensive systems require more resources and more time to produce the desired food products (Pitesky et al., 2009). The underlying principle in favor of increasing production to decrease environmental impacts is that the maintenance costs of the operation (such as enteric emissions per cow, emissions associated with infrastructure, emissions from manure management, etc.) are spread over more units of milk, thus decreasing each unit of milk's associated impacts (Bava et al., 2014; Guerci, Bava, et al., 2013; Pitesky et al., 2009). So even though each cow's impacts may be greater than a cow in a less intensive system, the greater milk production per cow means that the footprint of each unit of milk is similar to or lower than that from a less intensive system (Belflower et al., 2012; Capper, 2014; Weidema et al., 2008). This approach is usually supported by identifying an increasing global population which will need sufficient calories and macro/micronutrients, of which dairy products can be a valuable source (Knapp et al., 2014).

An oft-cited study in this vein is the 2009 article by Capper, Cady, and Bauman, who compare the resource intensity of U.S. dairy production in 1944 with the same in 2007. Their results identify that modern dairy uses 21% of the animals, 23% of the feedstuffs, 35% of the water, and 10% of the land required to produce the same volume of milk in 1944 (Capper et al., 2009). When comparing 2007 with 2017 using similar but updated methods, 2017 dairies used 74.8% of the animals, 82.7% of the feedstuffs, 69.5% of the water, and 79.2% of the land compared with 2007 (Capper & Cady, 2020). A study specific to California dairy parallels these results: in 2014 California dairies emitted 45-46.9% less GHGs, reduced water use intensity by 88.1-89.9%, and reduced land requirements for crop production by 89.4-89.7% per kg milk compared to 1964 (Naranjo et al., 2020). Crosson et al. (2011) note that intensification can be an effective mitigation strategy as long as N fertilizer levels are kept in moderation and the increased impacts from intensification are offset by productivity. Some research in this area has been specific to Bovine Somatotropin (bST), even though its overall use has decreased dramatically (“RBST,” 2017). Use of bST (or rbST) increases milk production per cow so that the overall operation requires fewer nutrient inputs and fewer waste outputs per unit milk, thus the overall environmental impacts for these systems as measured per unit milk can be lower (Capper et al., 2008; Johnson et al., 1992). Scholars suggest that focusing on efficiency per unit output in this way is key because the dairy industry is diverse (Stewart et al., 2009), and discussing more specific strategies would exclude various groups of producers (Place & Mitloehner, 2010).

Discussion

Dominant metric: Impacts per unit milk

In the research summarized above, the majority of scholars chose a similar metric to discuss environmental impacts of dairy products: impacts per kg milk (described as energy-corrected or fat- and protein-corrected milk, ECM or FPCM). This metric reflects aggregate impacts and so is particularly relevant for commenting on national or global concerns (National Research Council, 2003). Additionally, the life cycle analysis (LCA) studies that are frequently used to assess the environmental impacts of dairy often vary in small or large ways from one another, and using a standardized metric like this helps illuminate these differences (Place & Mitloehner, 2010).

The concepts of ECM or FPCM are not intuitive and require some explanation. While milk is seen as the perfect commodity (Dupuis, 2002), its composition varies across regions, operations, and breeds. Additionally, the same input (raw fluid milk) is used for different end products like cheese, butter, and powder milk. Nutrient-based metrics like ECM or FPCM help to compare milk of differing nutrient composition (Gerber et al., 2010) which is particularly useful since producers are often paid based on their milk's nutrient components (Penn State Extension, n.d.). Nutrient-based metrics also help to account for different products from the same input (Milani et al., 2011), and/or to compare multiple products that provide similar nutrients (Steinfeld et al., 2006). ECM and FPCM are calculated by correcting the nutrient content of milk to a set standard—for example, 4.0% fat and 3.3% protein for FPCM—to be able to compare and analyze milk of varying nutrient levels and coming from varying animals or breeds (Gerber et al., 2010). The ECM or FPCM metric focuses on select nutrients but that ignores other nutritional properties of the product

(Steinfeld et al., 2006) and risks falling into the problem of nutritional reductionism (Scrinis, 2008).

While there is widespread use of the impacts per kg corrected milk metric in both sectors of the literature summarized here, statements from authors in both sectors identify potential problems with focusing so heavily on impacts per unit milk. Many researchers pointed out a population effect, similar to California's attempts to reduce vehicle emissions: if the focus is on efficiency of individual units, the overall emissions will still increase if the population of producers—be it cars or cows—increases (Dumont et al., 2018; Perry et al., 2019; Press, 2015). Thus even though the GHG emissions per unit milk look favorable for an intensive operation as animal productivity increases, the total emissions from that intensive operation can still be significantly greater than less intensive operations (Casey & Holden, 2005a; Gerber et al., 2011; Herrero & Thornton, 2013). If overall production continues to increase, particularly in light of socioeconomic circumstances noted below, then there can be little to no net gain (Food and Agriculture Organization & Global Dairy Platform, 2018). Indeed, recent research from Capper and Cady (2020) show just this: while GHG emissions per million metric ton milk in 2017 were 80.8% of the equivalent volume of milk in 2007, because of increased milk production total GHG emissions increased by 1%. This can be the case with nutrient management, as well (Bouwman et al., 2013), where even very efficient operations can contribute to nutrient pollution if there are a large number of operations concentrated in a small enough area. Clustering of production operations may occur because local factors like climate, resource access, or regulatory landscape are favorable to the industry, or because development initiatives incentivize clustering (Kiminami & Kiminami, 2009). Regardless of the reason, this clustering entices related business entities (feed suppliers, processors, etc.) to locate nearby which helps lower the per unit production cost

(Gerber et al., 2007) and creates compelling reason to maintain the concentration of producers.

Several authors suggest that the heavy focus on specific elements of livestock production—such as emissions per unit milk—has oversimplified the case of livestock agriculture and its environmental ramifications (Herrero & Thornton, 2013; Salou et al., 2017). Because overall production increases are possible, reducing livestock agriculture's environmental impact may not be as simple as minimizing the impacts per unit milk (Flysjö et al., 2012). If a focus on efficiency lowers cost of production and thus the cost of animal products to consumers, an increase in total consumption (and production) due to lower food prices could outweigh any gains from intensification (Garnett et al., 2016; Garnett et al., 2017). Oversimplification can also occur by considering dairy production in isolation. If fewer cattle are able to produce more milk, that has ripple effects for the beef market which in the U.S. receives anywhere from 18-24% of its supply from culled dairy cattle (Geiser & Boetel, 2019); in the European Union the proportion is almost half (Cederberg & Stadig, 2003). If the dairy industry provides fewer cattle for beef, then the emissions savings from this may just be replaced by emissions from greater production of beef cattle which could even result in an overall increase in impacts (Weidema et al., 2008).

One possibility from the literature for moving beyond simplifications is to also look at area-based impacts. Crosson et al. (2011) found that expressing emissions on an area basis (per hectare) identified differences in environmental performance between operations that were not noticeable when emissions were expressed per unit milk. A range of authors identified a worse environmental scenario for intensive operations when using the impacts per hectare metric compared to impacts per unit milk (Bava et al., 2014; Cederberg & Mattsson, 2000; del Prado et al., 2010; Salou et al., 2017; van der Werf et al., 2009). Thus, if the environmental literature on dairy production has skewed too heavily towards the impacts per unit milk metric, a first step could be integrating impacts per hectare analyses alongside impacts per unit milk, to illustrate a more complete picture.

Impacts per unit milk in socioeconomic context

The discussion so far has focused on the quantitative side of dairy's (and more broadly, livestock's) environmental impact. Yet the metrics with which we evaluate and discuss dairy's environmental impact are used in a particular socioeconomic context. That context has important implications for how information about dairy's environmental impact is received and the actions which are taken in response. Currently both conventional and organic dairy producers are weathering a combination of stressors, including: sustained low milk prices due to high milk supply nationally and globally (Donaghy et al., 2016) plus decreasing demand (American Farm Bureau Federation, 2020), more recent impacts from a tariff war (Dickrell, 2018b; Hiltzik, 2018), and supply chain disruptions from the Covid-19 pandemic (Chrisman, 2020; Yaffe-Bellany & Corkery, 2020). Paradoxically, when faced with low milk prices—such as the period since 2015 when prices stayed generally below the cost of production (Hiltzik, 2018; Mollica, 2019b)—the tendency is for producers to squeeze out even more production to try and bring in a slightly larger milk check and stay afloat (Kaika, 2019; Nargi, 2018), which only further exacerbates the supply problem overall. Yet the high rates of dairy bankruptcies and closures—one per week in California, two a day in Wisconsin (Dickrell, 2020; Mollica, 2019a; Nargi, 2019)—show that many dairy operations are not able to survive in the current market (National Farmers Union, 2019). The dairy closures coincide with high concern over producer suicides, and several dairy processors made news by sending out milk checks along with a handout listing suicide hotline numbers (Kilgannon, 2018; Smith, 2018; Weingarten, 2017). Though the most publicized reports focus on the

Midwest and Northeast, the cost-price squeeze of U.S. agriculture and its associated stresses are prevalent for California dairy producers, too (Brock & Barham, 2013; Dickrell, 2018a; Fitchett, 2018). Narratives of dairies leaving California or going out of business due to costs or pressures of environmental regulations are familiar (Sayre et al., 2012; Sneeringer, 2011; Sneeringer & Hogle, 2008).

The current focus on efficiency optimizes dairy production systems for ideal circumstances. Operations that produce the most milk from the fewest cows in large overall quantities are set up to deliver large volumes of dairy products to retailers that can take in large quantities; for dairy this means schools, restaurants, and coffee shops (Chrisman, 2020; Yaffe-Bellany & Corkery, 2020). This supply chain relies on regular transportation, both to deliver the product and for consumers to travel to the schools and restaurants where they consume the product. In early 2020, the vulnerability inherent in optimizing for ideal conditions was made clear. The global coronavirus pandemic shut schools and restaurants across the United States, in an effort to keep groups of people from congregating and spreading the virus that leads to Covid-19 (BBC News, 2020). As a result, a seemingly illogical juxtaposition occurred: dairy producers were told by processors to dump their milk on-site, while at the same time consumers were running into empty milk shelves at the grocery stores or being limited to purchases of one or two gallons of milk per customer (Mulvany et al., 2020; Yu, 2020). The supply chain that was developed to supply large volumes of dairy products—propelled by highly efficient operations—was not able or willing to pivot away from delivering large volumes of dairy products to schools and restaurants and towards delivering smaller quantities to grocery stores and consumers (Marshall, 2020; Yaffe-Bellany & Corkery, 2020).

Agriculture's efficiency focus may have developed an overall production system—including processors and supply chains—able to maximize output and profit under ideal circumstances, but it did not create a resilient system able to adapt to significant disruption (Clapp, 2020). In contrast, smaller cooperatives and community-supported agriculture (CSA) models saw a boom in business during the coronavirus pandemic as consumers—all of a sudden needing to acquire the quantities of groceries needed to feed their families three meals a day at home—ran into empty shelves at grocery stores and sought options for home delivery (Ricker & Kardas-Nelson, 2020; Westervelt, 2020). These circumstances push back against the assumption that intensive production and distant supply chains can sufficiently feed our population, and identify the need to retain diversity in the forms of food production.

The current moment is a time of stress and transition for dairy producers. In an industry reeling from oversupply and resultant low prices, greater efficiency and higher productivity alone will not cause more stability for the producers who remain. The treadmill of production (Cochrane, 1979) means that on-farm efficiency and/or productivity improvements fail to result in net gains in light of sustained low or negative profits in the industry overall (Diamond, 2013). From an environmental perspective, as identified in previous sections, efficiency improvements are nullified if overall production continues to increase (Garnett et al., 2015). Neither does efficiency in the production stage help ameliorate food waste farther down the supply chain, if an excess of supply is not consumed (Messner et al., 2020). However, efficiency and productivity measures can be synergistic to improve both socioeconomic stability and environmental performance if they occur alongside something like supply management (Sharma, 2020).

Supply management in a dairy context generally aims to manage the milk inventory, including imports and exports, as a means of controlling volatile markets and establishing fair prices (National Farmers Union, 2019). Market swings make for uncertain production climates and impact the prices that producers receive, especially for sectors like U.S. dairy that are tied heavily to export markets (Martin, 2019). As a concept, supply management has been used in various parts of U.S. agriculture since after the Great Depression, when it was implemented to stabilize markets (Graddy-Lovelace & Diamond, 2017; Weingarten, 2018; Winders, 2009). Supporters point to Canadian dairy producers as evidence that the system can help provide stable prizes and prevent dairy producers from losing their farms (Martin, 2019), but also to successful milk cooperatives in the U.S. that manage supply among their producers (Graddy-Lovelace & Diamond, 2017; Weingarten, 2018). A national form of supply management is being supported by an increasing number of producer organizations to ameliorate low milk prices and stem the tide of dairy closures (Kaika, 2019; Nargi, 2019, 2020).

Supply management is also important to view from an environmental sustainability lens, which was its paired purpose when the U.S. used supply management to rebound from the Great Depression and Dust Bowl (Winders, 2009). This chapter has summarized the many efficiency gains made by dairy producers in recent decades and the accompanying environmental benefits. But it has also highlighted concern that these very gains can be nullified if the current oversupply continues and producers ramp up milk production just to scrape by and stay in business. A ceiling on production, however, would ensure that these impressive efficiency gains translate into lasting environmental improvements. That this could come alongside stabilized economic circumstances for farmers is a favorable win-win scenario. The logistics of a supply management program are daunting and there is certainly disagreement about whether public or private governance is best (Weingarten, 2018). Certainly, the current combination of decreasing demand, low prices, and a global pandemic mean that even processors who have incorporated degrees of supply management are struggling (The Ferndale Enterprise, 2020). What is clear from both the economic and environmental state of the industry is that some sort of growth management is key for a sustainable future, something the coronavirus pandemic has further underscored (Dykes, 2020).

Chapter 2. The landscape of California dairy

Introduction

Livestock production is a clear focus of climate change efforts, and California's livestock are no exception. California livestock production contributes approximately 23.15 million metric tons of greenhouse gas emissions each year, which is 69% of the state's agricultural total; 70% of livestock's contribution comes from dairy production (Sumner, 2014). In California, policies like the *Short-Lived Climate Pollutant Strategy* and associated State Bill 1383 target methane production from dairies and utilize incentives like grant programs to integrate climate-friendly dairy production practices.

While climate policies have livestock as an obvious target, effecting change can be more complicated. In 2015, the state Air Resources Board's *Short-Lived Climate Pollutant Strategy*—building from California's Assembly Bill 32, The Global Warming Solutions Act of 2006—identified methane biodigesters as a key technology to reduce methane emissions from California's dairy farms. In 2016, pushback from a range of agricultural groups argued that biodigesters are only applicable to a limited profile of farms based on size, access to capital, proximity to other farms or residential areas, etc., and the strategy thus excluded many dairies throughout the state. After this the state grant programs expanded to include non-digester practices to reduce methane (Kotin, 2016). The cap-and-trade funds used to support climate goals throughout the state now address two programs that target dairy emissions rather than one, addressing both digester and non-digester methane reduction strategies: Dairy Digester Research and Development Program (DDRDP) and Alternative Manure Management Program (AMMP) (Dairy Cares, 2019).

The conflict and subsequent adjustment surrounding methane reduction strategies illustrates that the range of agricultural operations can be more fully utilized to address environmental concerns if their diversity is understood and incorporated into policy recommendations (Clark et al., 2016). While it is commonplace for food processors and consumers to ask details about agricultural operations to meet their ethical goals—see, for example, the evolving use of rBST in milk ("RBST," 2017)—the specifics of production operations matter for creating desired policy outcomes, as well (Dickrell, 2019; Meyer et al., 2019a). Previous work on water quality regulations in California utilized knowledge about regional variability to implement successful initiatives (Meyer et al., 2019a). Yet policies crafted at broader scales can miss the importance of local conditions (Crosson et al., 2011).

In this chapter I aggregate information from secondary datasets and state agencies to clarify some of the diversity of California dairy production. I identify distinct conditions of the three main dairy regions of California (North Coast, Central Valley, and Southern California), and further subdivide two of those regions for a total of five representative areas, each represented by a county. I start by giving a brief overview of each county and then analyze relevant data comparatively, before discussing implications for environmental initiatives. As noted in the following section, this analysis comes at a time of change and upheaval which will likely affect the landscape of California dairy detailed here. While potential changes may alter the utility of this analysis, it can still be an important reference for those concerned with public policy to see nuance of the industry circa 2018. At some point, it may also serve as a useful tool to identify which regions and operations were able to survive the turbulence of 2019-2021, informing our understanding of farm and regional resilience.

Sources of Information

Data for this chapter mostly come from state and federal agencies, which due to privacy concerns aggregate data at the county level. The descriptive scheme presented here therefore uses information from five counties throughout California to illustrate the differing contexts of dairy production that exist in the state. The county level may not be the ideal scale to use for a discussion of farm diversity, but it stands as a compromise given the availability of county-level survey data. This scheme is informed by 5 years of researching with producers and industry representatives throughout the state, undergoing interviews and participant observation and engaging in archive research.

The majority of quantitative data presented come from two sources: the California Department of Food and Agriculture (CDFA) and the United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS). Where possible, CDFA numbers are used over NASS numbers. CDFA numbers have a minimum floor on the operations defined as dairies, so that farms with just a few dairy cows—which are not commercially viable operations as dairies specifically—are not included in averages; this contrasts with NASS numbers which include agricultural operations with as few as one milk cow (USDA NASS, 2019a). CDFA numbers are based on permits and production numbers, and informed by regular updates from personnel on the ground, so they are more reliable for the goal of characterizing commercial dairy production in California (Voss, 1993). Available data is limited to 2016 and 2017 for the most part, reflecting several sociopolitical trends. For NASS data, the last Census of Agriculture took place in 2017. For CDFA data, in 2018 the California dairy industry shifted to the Federal Milk Marketing Order (FMMO) for the first time in its history; this action dissolved the Dairy Marketing Branch of CDFA which kept detailed records of dairy operations, so for many records the most recent complete year of data is 2016 (for data collected biennially) or 2017.

Beyond the numbers that characterize dairy size and production, the environmental regulations that different parts of the state work under have been chronicled as an important influence on the diverse California dairy landscape (Sneeringer, 2011; Sneeringer & Hogle, 2008). My time in the field with dairy industry actors supported this assertion, as producers and public officials alike identified varying environmental regulations as a key distinction among forms of California dairy. Thus a second major component of data comes from the various regulatory agencies that govern California dairies. This qualitative data was gleaned from the websites of Regional Water Boards (regions 1, 2, 5, and 8), Air Pollution Control Districts (North Coast Unified, Bay Area, San Joaquin Valley, and South Coast), and county code/ordinance listings. The regulations included here do not represent an exhaustive list of all the requirements dairies may encounter, rather they constitute a description of regulations that apply generally to most dairies. Specific operations will certainly have circumstances that require them to follow additional regulatory guidelines (e.g., use of an anaerobic digester or composting manure for land application). I have tried to walk the line between including information about regulations that is useful to the discussion (e.g., identifying if regulations only apply to operations of a certain size), while not getting mired in regulatory details unless they identify an important difference between regions.

A caveat exists regarding timeliness of the data for this chapter. By nature, information about existing dairy operations, production numbers, prices received, etc., are out of date as soon as they are collected. Several key events leading into the years 2020 and 2021 require an explicit discussion about how the patterns identified here could change rapidly. First, as mentioned above, at the end of 2018 the California dairy industry switched to the

FMMO pricing system for the first time. While California producers had been paid by a system controlled at the state level, they are now paid by a system controlled at the federal level. The shift was undertaken by producers in the hopes of receiving better prices, during a time when the margin between milk prices and feed costs was becoming especially thin (MacDonald et al., 2020). Time will bear out if the FMMO shift was an effective way to buoy milk prices paid to producers, but what it means more immediately for this chapter is that much of the fine-scale data on producers and pricing that was under the umbrella of the CDFA is no longer available or calculated in a different manner. Secondly, going into 2019 the dairy industry was seeing high numbers of dairy closures (MacDonald et al., 2020), which seemed set to rapidly change the landscape of dairy production nationally and also in California. Beyond individual dairy closures, even industry giants were falling: whereas Dean Foods previously held approximately 70 percent of market share in most metropolitan areas (Howard, 2016), in 2019 it filed for bankruptcy (Valinsky, 2019). Third and most recently, the global coronavirus pandemic that took root in 2020 hammered the already precarious situation of many U.S. dairy producers. The dairy supply chains tailored to large volume consumers like schools and restaurants halted almost overnight, with dairy producers (along with producers of all types) dumping their product on-site while grocery store customers met empty shelves (Clapp, 2020; Marshall, 2020; Thornton, 2020; Yaffe-Bellany & Corkery, 2020). At the same time as agricultural incomes began to look grim, the off-farm incomes that farm families increasingly rely on to stay afloat (Behsudi, 2017; Dimitri et al., 2005; Mishra et al., 2002; Peters, 2016; USDA Economic Research Service, 2018) decreased as schools, businesses, and various service agencies rode out the cycles of closing and opening due to virus surges and recoveries (Cimini, 2020; USDA Economic Research Service, 2020). This convergence of changes and stressors could have a range of effects on the California dairy landscape, the details of which will not be known for some time. Therefore in some ways this chapter stands as a record of what the California dairy industry looked like circa 2017-2018, a period before serious potential change came to California dairy and U.S. agriculture more broadly.

Characterizing California Dairy

Statewide dairy scene

By many metrics California leads the nation in dairy production. In 2017 California had the largest milk cow inventory at 1.8 million and the most milk sales at $6.5 billion, with Wisconsin as the runner-up at $5.2 billion (USDA NASS, 2019b). California produces 18% of the U.S. supply, more than any other state (CDFA, 2019b). For the years 2016-2017, this meant producing more than 39 billion pounds—or 390 million hundredweight (cwt)—of milk (CDFA Dairy Marketing Branch, 2018; USDA NASS, 2017a). California dairy makes up an even larger share of U.S. dairy exports, contributing 33 percent in 2018 (CDFA, 2019a). That year it brought in $1.7 million at an increase of 6 percent over the previous year, putting dairy in third place for California's top valued export commodity behind almonds and pistachios (CDFA, 2019a).

The 2017 Census of Agriculture puts the number of California dairies at 1,321 (USDA NASS, 2019a), though this constantly changing metric is frequently discussed among industry professionals at conferences and meetings, with some sources suggesting the number of dairies in California has been dropping by one dairy each week (Nargi, 2019). This trend of decreasing dairy operations is offset in overall production by the increasing size of remaining farms (MacDonald et al., 2020). MacDonald et al. (2020) illustrate this trend through the median size of dairies nationwide: in 1987 the median dairy herd was 80 cows, and in 2017 the median herd was 1,300 cows. From 2007-2017 California dairy herds had a 25% increase in average herd size (CDFA, 2019b).

While dairy is the leading commodity for cash receipts in California, this status glosses over difficult recent years. Milk production in 2018 increased by 1.5 percent but the cash receipts received dropped by 2.9 percent from 2017; average milk prices received in 2018 were $15.78 per hundred pounds of milk (cwt), down from $16.50 per cwt in 2017 (CDFA, 2019b).

Production occurs in the north, central, and southern parts, but it is not uniform throughout the state, as this chapter will detail. The description of dairy production outlined below builds from regions used by CDFA for their surveys regarding cost of production (CDFA, n.d.-a). CDFA's four survey areas of North Coast, North Valley, South Valley, and Southern California (See Figure 1) are useful starting points both in terms of available data but also for the forms of dairy production that exist in California. For the purposes of this chapter the North and South Valley regions are also discussed under the umbrella of the Central Valley region, since in many cases these counties have matching regulatory requirements.

Figure 1. CDFA dairy regions

Map reproduced from CDFA's regional map: https://www.cdfa.ca.gov/dairy/pdf/ca-cop-sm-clr.pdf

North Coast

The North Coast region is composed mainly of Del Norte, Humboldt, Mendocino, Sonoma, and Marin counties (CDFA, n.d.-a). Unlike field crops which discuss agricultural operations by acreage, livestock operation size is reflected in the number of animals—or herd size—and in the North Coast there is an overall average herd size of 370 cows per operation (Meyer et al., 2019a). CDFA data for this general region shows that as of 2015 herd sizes were overwhelmingly under 500 cows (153 dairies), with some in the 500-999 cow range (16 dairies) and only one operation exceeding 1,000 cows (CDFA Animal Health Branch, 2015). The region's plentiful rainfall allows for pasture dairies, lending this region to organic production. Organic dairy certification requires that dairy cattle graze for at least 120 days during their geographic region's grazing season, and during the grazing season an average of 30% of dry matter intake must come from grazing (Rinehart & Baier, 2011). Two counties selected here help illustrate the range of dairy production environments that exist within the North Coast region.

Humboldt County: Rural North Coast

Humboldt is the second most northern county in the North Coast region (See Figure 1), with generally sparse population across its over 4,000 mi^2 (State of California, 2000) and iconic ecosystems like redwood forests, Eel River, and Humboldt Bay (Grantham, 2018). While weather patterns vary between coastal and inland areas, an important dairy location like Ferndale near the coast sees temperatures generally range from 38-65F with 42 in. precipitation (Western Regional Climate Center, 2020). Milk ranks as Humboldt's top agricultural commodity by cash value (California Department of Food and Agriculture, 2020).

Marin County: Exurban North Coast

Marin County is the farthest south county in the North Coast region (See Figure 1), its over 800 mi^2 sitting just north of San Francisco. Dairies in this and neighboring Sonoma County have historically benefitted from their proximity to San Francisco consumers (Pranka, 2014), though development pressure from the city has catalyzed local efforts to preserve open space and agricultural land (Ackerly et al., 2018; Guthey et al., 2003). Temperatures generally range from 38-81F with 35 in. of annual precipitation (Western Regional Climate Center, 2020), in a region dominated by oak savanna and annual grasslands (Ackerly et al., 2018). While pasture production is common, the varying soil conditions necessitate diverse management practices within the pasture model (Guthey et al., 2003). Milk is Marin's top agricultural commodity by cash value (California Department of Food and Agriculture, 2020).

Central Valley

In recent times the top dairy producing counties by volume are consistently from the Central Valley, and together they make up the clear majority of California's dairy production (CDFA, 2014). The valley in general has fertile soil as a result of millennia of flooding prior to engineered flood control (Johnston & McCalla, 2004). Due in part to its large regional spread, the Central Valley is split into North and South sections. According to the CDFA Cost of Production Survey regions, North Valley includes 20 counties from Monterey north to Shasta, while South Valley includes the four counties of Fresno, Kings, Tulare, and Kern (CDFA, n.d.-b). The Central Valley region has an overall average herd size of 1,403 cows (Meyer et al., 2019a), and the two Central Valley counties profiled help illustrate the variation in this high production area.

Merced County: North Valley

Dairies in the North Valley region span a range of herd sizes, though in 2015 the greatest number existed under 1,000 cows; in this region almost 500 dairies were under 1,000 cows, while 124 were over 1,000 cows (CDFA Animal Health Branch, 2015). Merced lies at the south of the North Valley region (See Figure 1) with almost 2,000 mi^2 in the Central Valley basin between Yosemite National Park and Monterey Bay. Characteristic of the Central Valley, temperatures generally range from 36-97F throughout the year and dairies around Merced see approximately 12 in. of precipitation a year (Western Regional Climate Center, 2020). Dairying in Merced initially grew to supply the San Francisco Bay Area with milk (Johnston & McCalla, 2004), and today milk ranks as Merced's top agricultural commodity by cash value (California Department of Food and Agriculture, 2020). Farming dominates the land use but Merced is also characterized as the fastest growing county in the state by population (Westerling et al., 2018).

Tulare County: South Valley

Dairy herd sizes in the South Valley region skew larger and as a result carry higher production. As of 2015 the region had 212 dairies under the 1,000-cow mark and 365 dairies over it—including 173 dairies over 2,000 cows[1] (CDFA Animal Health Branch, 2015). Tulare County has over 4,800 mi^2 of land, with an eastern portion in the Sierra Nevada range including Sequoia and Kings Canyon National Parks and a western portion in the Central Valley basin where farming is the dominant land use (Westerling et al., 2018). Similar to

[1]A discrepancy worth noting: In the regions used to outline this chapter, Madera County is included in North Valley, but in the survey that breaks down herd sizes into ranges it is included in South Valley. In 2015 Madera had 41 dairies with an average size of 1,882 cattle per dairy (CDFA, 2017), so reallocating its dairy operations would adjust the North and South Valley totals but not change the overall trend.

Merced County, dairies in Tulare see temperatures generally range from 37-99F with around 10.5 in. precipitation per year (Western Regional Climate Center, 2020). Dairying in the region grew from a combination of water projects and the exodus of dairy from southern California (Johnston & McCalla, 2004), and today milk ranks as Tulare's top agricultural commodity by cash value (California Department of Food and Agriculture, 2020).

Southern California

Southern California production occurs mostly in Riverside and San Bernardino counties, but also includes San Luis Obispo, Santa Barbara, Los Angeles, San Diego, and Imperial counties (CDFA, n.d.-b). It has a regional average herd size of 1,002 cows (Meyer et al., 2019a). The breakdown of 2015 dairies showed almost 100 dairies evenly distributed under the 2,000 cow threshold, and only four dairies with 2,000 or more cows[2] (CDFA Animal Health Branch, 2015).

Riverside County

Riverside County has over 7,300 mi^2 stretching east to west across Southern California's Inland Empire, including less populated desert with Joshua Tree National Park in the east and densely populated areas adjacent to Los Angeles in the west. Southern California was the birthplace of the dry-lot mode of dairy production in which large numbers of cows are concentrated on relatively small acreages, which is possible only by purchasing all feed from off-site (Gilbert & Akor, 1988; Gilbert & Wehr, 2003). Dairying in this county grew as

[2]In the regions used to establish this chapter, San Luis Obispo and Santa Barbara Counties are included in South Valley, but in the survey that breaks down herd sizes into ranges these counties are in Southern California. Given the low number of dairy operations in both counties (for 2015 CDFA declined to report data on these counties individually, which generally indicates a desire to avoid disclosing data about individual operations) this does not substantially change the overall picture. At most it may increase the proportion of operations under 500 cows (USDA National Agricultural Statistics Service, 2019c).

a result of production moving out of the urbanizing Los Angeles milkshed (Johnston & McCalla, 2004), though the number of dairies decreased drastically in recent decades as a result of further urbanization (Guthey et al., 2003). Today milk ranks as Riverside's second highest agricultural commodity by cash value (California Department of Food and Agriculture, 2020). In the Hemet area towards the west of the county where many dairies remain, temperatures generally range from 38-99F with 11 in. of precipitation annually (Western Regional Climate Center, 2020); precipitation can vary greatly, though, with large portions of annual totals coming from a few storm events (Hall et al., 2018).

Regional Comparisons

The dairy production regions outlined here share some similarities. All counties have increased their herd sizes in recent years, in response to pricing pressures (MacDonald et al., 2020; Powell et al., 2010). The combination of current milk pricing, extant federal subsidies, and technical economies of scale means larger dairies have advantages in the current market (Jackson-Smith & Buttel, 1998). Since the 1950s dairies of all forms have seen an increased efficiency in milk production per cow, an increase in herd size, and more concentrated geographic production (Lyson & Gillespie, 1995) among fewer dairies (MacDonald et al., 2020). For dairies and agriculture in general, industrialization represents one adaptation to the "cost-price squeeze" of higher input costs and stable or lower commodity prices that decrease profit margins (Barham & Jackson-Smith, 2000; Harrison & Lloyd, 2012; Howard, 2016). As agricultural operations increase in size, they sometimes encounter more nuisance complaints from neighbors. All five counties profiled here have some form of a Right to Farm ordinance, which demonstrates the county's prioritization of certain spaces as agricultural spaces, and aims to buffer farms against nuisance complaints in those areas. Beyond these similarities, however, a range of characteristics help to distinguish among California's dairy regions.

Production metrics

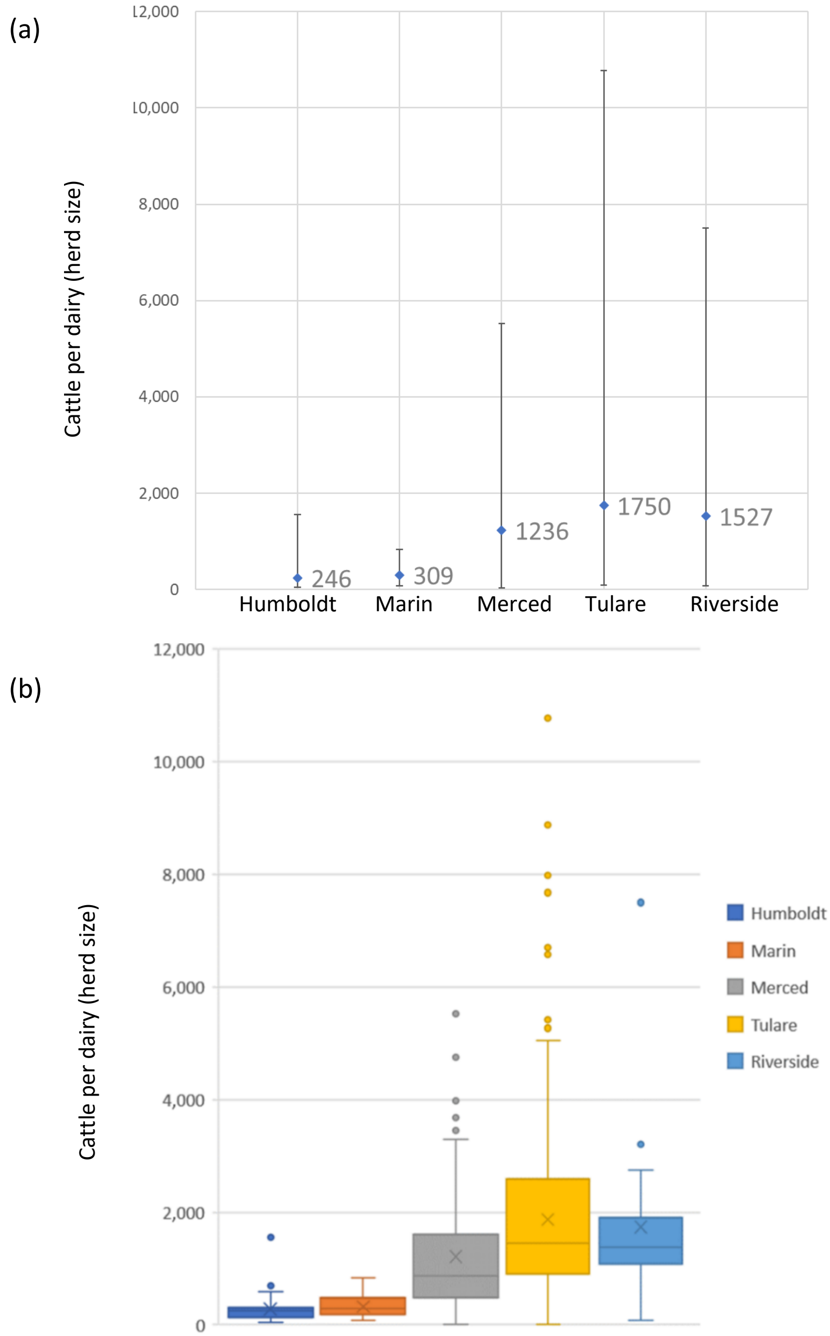
Precise herd size and production volume vary greatly among the counties profiled here. Table 1 compares production numbers from each of the profiled counties side-by-side. Figure 2 visually demonstrates how the mean, median, and range of dairy operations compare among counties.

Table 1. Farm and production numbers for 5 counties

	Humboldt	Marin	Merced	Tulare	Riverside
Number of[1] dairies	60	25	217	269	27
Total milk cows[1]	14,815	7,718	268,176	470,692	41,235
Average dairy herd size[1]	247	309	1,236	1,750	1,527
Range of dairy herd sizes[2]	49-1,556	85-830	33-5,520	90-10,776	83-7,500
Total production (cwt)[3]	2,353,000	1,328,000	61,647,000	110,412,000	8,735,000
Percentage state production[3]	0.6%	0.3%	15.4%	27.4%	2.4%

[1]Data from California Agricultural Statistics Review, (2016-2017). [2]Data from State Water Resources Control Board regulatory permits (2020), though many filed prior to 2020. [3]Data from County Agricultural Commissioners (USDA NASS, 2017a).

Figure 2. Herd size by county



(a) Average herd size indicated with blue diamond and called out numerically. Range of herd sizes for permitted operations depicted by error bars. (b) Average herd size indicated with an X; median indicated with line through the middle of the box. Circles indicating outliers illustrate operations which are notably larger in relation to others. Data from: California Agricultural Statistics Review (2016-2017); State Water Resources Control Board regulatory permits (2020)

The Central Valley clearly has the highest concentration of farms, dairy cattle, and dairy production, reflecting recent shifts in California's dairy landscape (Sneeringer, 2011; Sneeringer & Hogle, 2008; Surls & Gerber, 2016). Dairy producers who in recent decades sold land at a profit in the urbanizing Los Angeles milkshed, shifted north and established many of the large dairies that now populate the Central Valley (Cross, 2001; Gilbert & Akor, 1988). Because the flat Central Valley of California poses few geographic limits on the size of dairies there, it was a logical place for capitalist expansion (Gilbert & Akor, 1988). Like other intensifying dairies following the neoclassical model (Lyson & Gillespie, 1995), these operations relied on increasing milk production per cow as well as improved nutritional science—e.g., total mixed rations—to support large herds and large volumes of production (Capper et al., 2009; Jackson-Smith & Buttel, 1998). Unlike their Southern California counterparts, these dairies acquired large landholdings, for everything from feed production to commodity diversification.

Looking at percent of state production combined with total number of cows highlights how closely the number of cattle in a county predicts overall production, with important deviations for local modes of production. Marin contributes .3% of state production and has roughly half the cattle of Humboldt, which doubles Marin's production at .6%; this suggests a fairly consistent volume of production per cow and minimal between-farm variation. Yet Riverside has roughly double the cattle of Marin and Humboldt taken together, but more than double their percentage of state production (2.4%); this greater production per cow reflects the difference in volume of milk production between mostly pasture dairies in the North Coast (Marin and Humboldt) and corral operations in Southern California (Riverside) with higher proportions of grain/concentrates in the diet, as well as the capacity for larger herd sizes with conventional production (Lee & Sumner, 2018).

A particularly interesting parallel exists between Marin and Riverside counties. The number of farms in each county is almost exactly the same (25 and 27), and the smallest herd in each county is likewise a near match (83 and 85). Yet their production is distinctly different: Marin's average herd size of 309 cattle and total production of 1.3 million cwt is dwarfed by Riverside's average herd size of 1,527 and 8.7 million cwt total production. As the contrast suggests, the North Coast and Southern California counties represent two distinct means of evolving and preserving dairy in California (Gilbert & Akor, 1988; Gilbert & Wehr, 2003; Guthey et al., 2003). The drylot dairying prevalent in Southern California came out of the Los Angeles milkshed. Here the high cost of land prompted milking operations to exist on relatively small plots of land where producers generally bought their feed instead of producing it on-site (Surls & Gerber, 2016). They also integrated the latest technology and relied on more hired labor to produce greater quantities of milk for the conventional market (Gilbert & Wehr, 2003). This reflects the intensification of operations—propelled in the name of efficiency—that has characterized US agriculture for decades (Blayney, 2002; Capper et al., 2009; Cochrane, 1979; Fitzgerald, 2003; Henke, 2008; Hightower, 1973; Jackson-Smith & Buttel, 1998). In the Marin and Sonoma North Bay areas, a combination of agricultural land conservation and niche marketing has pushed against the modernization trend, buoying small pasture-based dairy operations (Guthey et al., 2003) and reflecting what Van der Ploeg (2000) termed "farming economically" (see also Hassanein, 1999).

Organic production

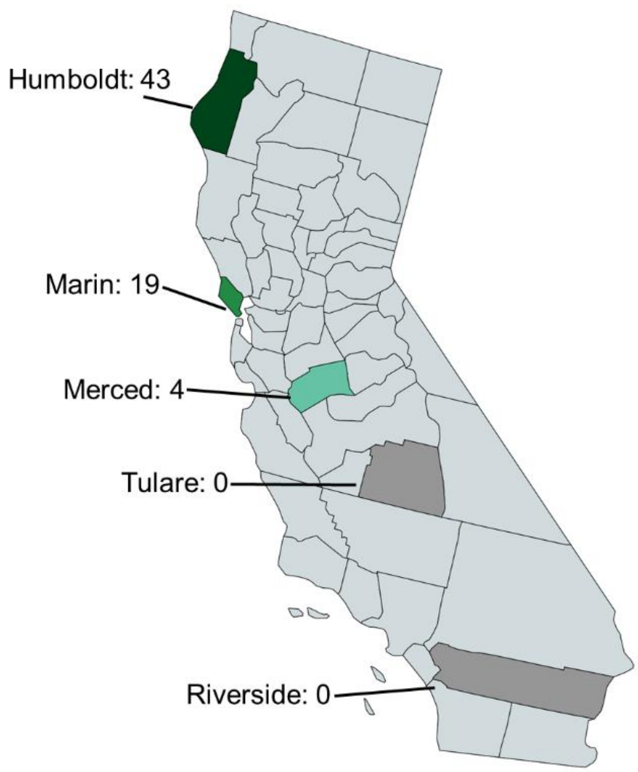
As identified in the discussion around Table 1, dairy regions are characterized in part by the market for which they produce. Table 2 and Figure 3 illustrate how the extent of organic production changes as you move from north to south, which mirrors the general precipitation gradient.

Table 2. Organic acreage for 5 counties

	Humboldt	Marin	Merced	Tulare	Riverside
Acres organic dairy, 2018[1]	12,537	12,872	2,489	0	0
Number organic dairies, 2020[2]	43	19	4	0	0

[1]Data from California Agricultural Organic Report (2018). [2]Data from personal communication, California State Organic Program (2020).

Figure 3. Organic operations by county



Number of organic operations per representative county as of 2020. Data from CA State Organic Program personal communication, 2020.

In 2016 cow's milk was the most purchased organic product in the US (Bialik & Walker, 2019), making it an appealing market for producers. Organic milk production—with its pasture requirements—is clearly concentrated in the north of the state where precipitation is more plentiful and reliable (NOAA National Centers for Environmental Information, 2020). Humboldt and Marin counties both have around 12,000 acres of organic production, but Marin has fewer than half the farms and just a few dairies that are not organic. This indicates that Marin is more reliant on organic production. Indeed, the exurban pressures—particularly the high cost of land and pressure to develop—that exert themselves on Marin's land just north of San Francisco necessitate creative and adaptive efforts to keep agricultural land, including community-supported land conservation efforts and agritourism (Clark et al., 2016; Digitale, 2016b; Guthey et al., 2003; MALT, 2020). Marin and neighboring Sonoma have used organic price premiums as a life raft to keep local dairies in production (Digitale, 2016a).

While Humboldt and Marin have the most organic dairy production of the counties profiled here, Merced County in the Central Valley includes organic representation, as well. This pushes back against simple characterizations of California dairy, such as the notion that organic production only happens along the north coast. Beyond geographic misconceptions, as has been noted by other scholars (Dupuis, 2002; Guthman, 2004), the organic food label itself can also be misleading. While numerous small organic producers exist who are committed to the organic philosophy— certainly in the counties profiled here— much of the industry represents post-Fordist capitalism (Busch & Bain, 2004; DuPuis, 2000; Friedmann & McMichael, 1989) as organic milk production exhibits a high degree of concentration and subcontracting and a heavy emphasis on marketing. Two firms—Horizon and Organic Valley—have historically had a clear majority of the organic dairy farms in the U.S., contracting with as much as 75% of producers (Su et al., 2013). Their highly centralized structure is in some ways necessitated by the niche consumer market of organic milk, but it means distribution (as well as marketing and retail) makes up a larger portion of organic milk prices than conventional milk prices (Diamond, 2013). These companies largely subcontract processing operations and thus avoid infrastructure costs, making their role primarily one of marketing firms (Diamond, 2013). Clearly there is a disconnect between the image of organic milk and the firms behind a large portion of that milk (DuPuis, 2000; Dupuis, 2002).

Milk pricing

Milk pricing is notoriously complicated. A joke frequently told at industry meetings is that “five people in the world know how milk is priced in the U.S.—and four of them are dead” (Farm Bureau, 2019). A simplified description of the process to determine the base milk price—that is the milk price without any premiums added to it, e.g., for organic milk—follows. Commodity prices (butter, cheese, dry milk products) are used to determine values of components (protein, butterfat, nonfat solids and other solids) which are used to determine prices for different end-product classes (I-IV), a combination of which forms shared revenue pools for groups of similarly-situated producers who are then allocated farm-level minimum payments (Farm Bureau, 2019). While milk pricing is an absolutely crucial factor for the dairy industry, it is fully understood by only a few; the process of making it legible to the state has made it mystifying to the cultivators (Scott, 1998, p. 48).

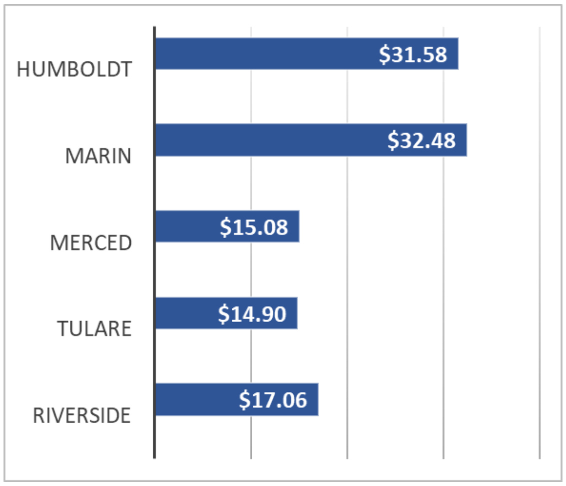
California’s previous state-based milk marketing order set minimum prices for milk that integrated differences in regional marketing and transportation costs in a pattern reminiscent of von Thünen’s rings of agriculture organized around cities (Fielding, 1964; von Thünen, 1826). On a national level as well, the milk marketing order arrangements that determine prices for dairy producers today came out of Agricultural Adjustment Act efforts in the 1930s which depicted manufacturing zones and pricing curves radiating from consumer areas; the current fluid milk classes and blend prices found in milk marketing orders still reflect 1930s manufacturing zone logic (Block & DuPuis, 2001). The new California federal marketing order includes a Producer Price Differential (PPD) which is adjusted by location; this means the PPD is adjusted based on the difference between the price paid for the Los Angeles area zone and the price paid at the location to which a particular producer's milk is delivered (USDA Agricultural Marketing Service, 2018). Clearly, proximity to consumers and processors still heavily influences the price paid to producers for milk. Table 3 and Figure 4 compare Grade A milk pricing for the profiled counties during the time when California was still on its state marketing order, with the important caveat that these aggregated prices reflect payments to producers and include premiums for things like organic milk. Organic milk production in California has a 70% higher cost than conventional milk produced in confinement dairies (Lee & Sumner, 2018), which is why a higher price must be paid to organic producers.

Table 3. Prices paid to producers for 5 counties*

	Humboldt	Marin	Merced	Tulare	Riverside
Grade A price per cwt	$31.58	$32.48	$15.08	$14.90	$17.06
Grade A total value	$65,403,000	$43,135,000	$858,441,000	$1,641,339,000	$149,019,000

Data from County Agricultural Commissioners (USDA NASS, 2017a). *Note that numbers reflect prices paid to producers, which includes price premiums for organic milk.

Figure 4. Average milk price received for 5 counties



Prices are averages for all producers in the county. Differences reflect prevalence of price premiums in the North Coast counties, as well as location differentials mandated by government pricing regulations for conventional milk, which adjust payments based on proximity to Los Angeles (USDA Agricultural Marketing Service, 2018). Data from County Agricultural Commissioners (USDA NASS, 2017a).

Table 3 illustrates the difference in pricing between regions with most or all conventional milk and regions receiving an organic milk price premium; this difference is why a high-cost area like Marin can use organic production as a means of retaining its dairy operations (Digitale, 2016b). The price difference between Southern California and the Central Valley counties also reflects the importance of the Los Angeles milkshed in determining price. Figure 4 compares these values visually.

Producer characteristics

Though limited, the available information regarding producer demographics illustrates some variation among California dairies, as demonstrated in Table 4. In collecting this information, the Census of Agriculture defines a producer as someone who is involved in making decisions for the operation and thus excludes labor not involved in decision-making; it also limits survey respondents to listing a maximum of four producers for their operation (USDA NASS, 2019a, p. B-19). Operations with at least one female producer were more prominent in the northern three counties profiled here (Merced, Marin, and Humboldt), and the northernmost county (Humboldt) was the only region able to report farm and sales data for American Indian and Alaska Native producers. Hispanic producers were more common in the southern three counties (Merced, Tulare, and Riverside).

The clearest trend depicted in Table 4 is that the vast majority of dairies throughout California are operated by producers identified as white. This representation comes in part due to particular historical trajectories of European immigrant groups who established dairying in California (Graves, 1969; Guthey et al., 2003), but it also reflects farm ownership in the US broadly (Bilecky, 2019). The overrepresentation of white farm owners relative to the general population has been well documented to reflect historical discrimination and injustices (see, e.g., Graddy-Lovelace, 2017). In the U.S. broadly this took the form of the government undercutting the Freedman's Bureau, instituting Alien Land Laws, and routing support programs away from farmers of color (Bilecky, 2019; Ginapp, 2003). In California, agricultural injustice traces back to Spanish missions targeting indigenous groups for forced farm labor (Fischer, 2015; Surls & Gerber, 2016). And despite the modern imaginary of the American West cowboy as a rugged white male, the cattle industry of the West was populated by Native American, Hispanic, and Black cowboys and cowgirls (Fischer, 2015; Iverson, 1994; T. Jordan, 1992; Nodjimbadem, 2017). The distribution of farmland and ranches today, and the popular idea of what farmers and ranchers looked like historically, comes out of a history of societal and institutional discrimination with which we are only beginning to contend (Tyler & Moore, 2013).

Table 4. Producer demographics for 5 counties

		Humboldt	Marin	Merced	Tulare	Riverside
Female	% farms	62	38	53	28	12
	% sales	60	42	48	24	13
Hispanic	% farms	2.3	--	15	12	12
	% sales	--	--	14	11	18
American Indian/ Alaska Native	% farms	4.6	--	--	.89	--
	% sales	4.3	--	--	--	--
White	% farms	100	--	98	100	100
	% sales	100	--	98	100	100

Data from US Census of Agriculture (USDA NASS, 2019a). Farms could report information on up to four producers per operation. Dashed line (--) indicates no data was given for this category. No counties listed here reported producers in the following categories: Black, Asian, Native Hawaiian/Pacific Islander.

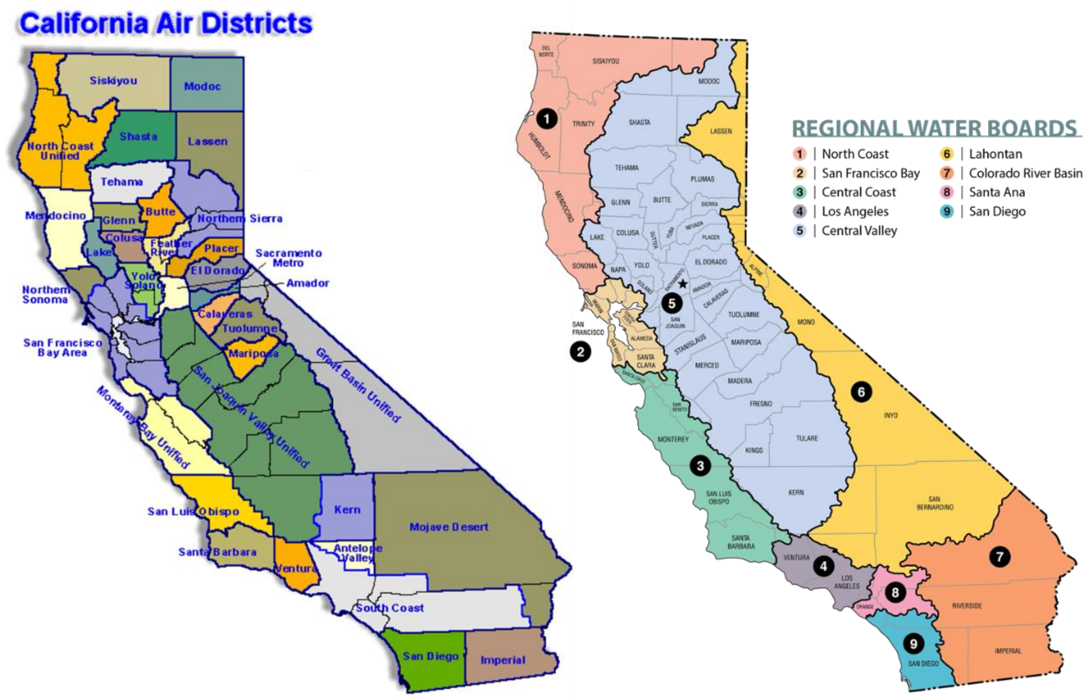
Table 4 presents producers as a percentage of total farms and a percentage of overall sales. This was done because the source for this data (USDA NASS, 2019a) includes very small operations with only a few cows; presenting the number of dairies that indicate a characteristic (like female producers) alongside the proportion of total sales that indicate that characteristic could help identify if operations with underrepresented producer groups skew to a particular size. In the data presented here, any difference between the proportion of underrepresented groups by farms or by sales was small enough that no confident conclusion can be drawn. Where underrepresented groups have lower percentage overall sales than their percentage of farms, this could reflect the observed trend that socially disadvantaged farmers and ranchers generally make up a larger proportion of operations that are smaller and bring in less revenue (Horst & Marion, 2018; USDA Economic Research Service, 2019). This underrepresentation reflects a history of discrimination and broader societal inequalities, particularly related to land ownership (Bilecky, 2019; Ginapp, 2003; Holt-Giménez, 2015).

Environmental Regulations

The diversity of dairy as an industry, as well as California's broad geographic variation, means environmental problems and their potential solutions will not be the same across regions which might vary considerably (Sumner, 2014). This complicates a general discussion of dairy's environmental impact, but some overall trends are worth noting. At all dairies, manure management is a large component of the environmental concern. In larger confinement facilities that are more common in the Central Valley and southern California, manure is often collected by flushing it from facilities with recycled water (which is subsequently reused for crop irrigation) and then collecting manure in lagoons (Dairy Cares, 2020) which have important potential to impact air and water quality (Kaffka et al., 2016). The anaerobic conditions of these manure ponds lead to methane production, so these facilities will also be included in future regulations to limit methane production for climate mitigation (Lee & Sumner, 2018). In areas with more pasture grazing—as in the north of the state—manure lagoons can still be an environmental concern but the impact of cattle in riparian areas is also a prominent issue (Meyer et al., 2019b). For all dairies that apply manure or manure effluent to cropland, the potential for nutrient leaching or runoff (Kaffka et al., 2016) prompts regulation via nutrient management plans, as well. Lastly, Central Valley and southern California areas which see less regular precipitation and have more confinement dairies have both nitrogen oxides (NO_x) and particulate matter pollution as additional environmental concerns.

In light of these environmental impacts, California dairy producers and the broader dairy industry are subject to a range of environmental regulations. Many are facilitated at local or regional levels by regulatory bodies or private industry partners, though most are driven by state or national environmental quality objectives. Producers generally have most experience with the air and water quality regulations implemented by California's air and water resource boards, though there can be other environmental initiatives, as well. While dairies in each county discussed here work under air and water regulations in order to meet state and federal objectives, the specifics depend on local conditions and how regulatory agencies decide to implement air and water quality objectives in the area. Figure 5 includes maps of air and water regulatory districts for California. The air and water agency boundaries sometimes correlate for areas like the San Francisco Bay Area or the San Joaquin Valley, but not many other parts of the state.

Figure 5. Air and water regulatory jurisdictions for California



Maps from: arb.ca.gov (air district map) and waterboards.ca.gov (water boards map)

California's regulatory agencies manage a number of key programs to control dairy's environmental impacts. To manage water quality on dairies, all regions included here offer general permits—called orders—which dairy operations can apply to in lieu of individual permits from their regional water board. Orders implement state water quality provisions but do not necessarily cover point source discharges to surface waters, which per the Clean Water Act requires a National Pollutant Discharge Elimination System (NPDES) permit. To qualify under the order dairies must outline their water quality management plans via a range of documents, and they must also complete regular visual inspections of pollution prevention measures (with photo documentation) and sample required material. Each year dairies also submit an Annual Report which summarizes the monitoring data. Due to concern over salt and nitrate levels in the Central Valley, new salt and nitrate control programs are also under way via the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program. The CV-SALTS control plans use similar measures as the regional general orders: if dairies are required to comply there will be monitoring and reporting requirements, as well as discharge limitations. Both salt and nitrate control plans allow for a traditional permitting option using known strategies, or an alternative compliance option to research and identify new strategies. Air districts display more localized means of managing air quality on dairies, and do not have a statewide parallel to the general permits of the regional water boards.

Table 5 combines dairy-specific environmental regulatory information for each representative county into a table with each county's information side-by-side. There are certainly more environmental regulations present in California that might apply to dairies—for example, the state's Sustainable Groundwater Management Act may be particularly important for dairies located on or near critical groundwater basins—but here the content is focused on regulations that apply to most/all dairies in a county, with the most notable exception that some dairies in a county fall under the minimum size requirements.

A breadth of information is included in Table 5, but some key points are necessary to call out. Of the four water board regions with general orders covering waste discharge requirements, only Region 8 (Santa Ana) uses theirs to double as a National Pollutant Discharge Elimination System (NPDES) permit which addresses point source pollution. Animal feeding operations (AFOs) are considered point source pollutants based on their size (for dairies this generally means 700 or more cows) and/or their capacity to be significant polluters in a given context. Due to the specific context of the Santa Ana region—including local geography and the aggregate impact of all AFOs in the area—the Region 8 Water Board determined that AFOs with 20 or more dairy cattle have potential to be significant polluters (California Regional Water Quality Control Board Santa Ana Region, 2019). Dairies under this permit are required to submit documents and undergo monitoring and reporting procedures which mirror those required in Regions 1, 2, and 5. Additionally, local areas with impaired water bodies have specific management criteria which further limit discharges or land application of manure. Though Riverside— the county representing the Santa Ana Region— only showed 27 dairies as of 2016, the local geography, use, and historical context necessitates treating dairies as point source polluters. At the same time the board covering Merced and Tulare counties, with upwards of 200 dairies each, does not take this same approach. This highlights the context-specific nature of agriculture and its environmental footprints.

Though the Region 5 dairies (Merced and Tulare counties) are not under a broad NPDES permit for point source polluters, Table 5 shows they are under a range of requirements unique to Region 5. This includes additional documents for the water board's general order as well as additional sampling requirements and a summary report after 6 years. They also have the new CV-SALTS program to control salt and nitrate levels in groundwater. The additional efforts reflect the large numbers of dairies in the Central Valley region and the water quality issues that can arise in this context, particularly where vulnerable groundwater resources are present (Burow et al., 2013; Harter et al., 2002). Meanwhile the North Coast counties (Regions 1 and 2) include grazing-specific documents that are not present in the other counties.

The three southernmost counties (Merced, Tulare, and Riverside) all see more air quality requirements than the North Coast counties, as well as distinct vector control measures. This resonates with the general difference in air quality among the different areas (see, e.g., U.S. Air Quality Index, 2020), as well as the distribution of vector-borne disease risk (Aliferis, 2016).

Table 5. Environmental regulatory information for 5 counties

		Humboldt (Region 1)	**Marin (Region 2)**	**Merced (Region 5)**	**Tulare (Region 5)**	**Riverside (Region 8)**
Water	NPDES permit	--	--	--	--	Yes
	Water quality plan	Yes	Yes	Yes	Yes	Yes
	Grazing plan	If applicable	If applicable	--	--	--
	Nutrient management plan	If applicable	If applicable	If applicable	If applicable	If applicable
	Preliminary Dairy Assessment items	--	--	Yes	Yes	--
	Monitoring Well Plan	--	--	If applicable	If applicable	--
	Salinity Report	--	--	Yes	Yes	--
	Inspections and photos	Yes	Yes	Yes	Yes	Yes
	Sampling requirements	Surface and groundwater	Surface and groundwater	Wastewater, solid manure, irrigation water, plant tissue, soil, supply wells	Wastewater, solid manure, irrigation water, plant tissue, soil, supply wells	Wastewater and manure
	Annual Report	Yes	Yes	Yes; summary report after 6 years	Yes; summary report after 6 years	Yes
	CV-SALTS program	--	--	Yes	Yes	--
Air		**Humboldt (North Coast)**	**Marin (Bay Area)**	**Merced (San Joaquin)**	**Tulare (San Joaquin)**	**Riverside (Santa Ana)**
	Livestock rule(s)	--	Yes	Yes	Yes	Yes
	Size of herd for livestock rules	--	1,000+ milk cows	500 milk cows	500 milk cows	1,000+ milk cows (Rule 223); 50 cows (Rules 1127, 1186)
	Dust mitigation rules	--	--	Yes	Yes	Yes
	EPA non-attainment areas	--	8-hour Ozone (2015)	8-hour Ozone (2015); PM2.5 (2012)	8-hour Ozone (2015); PM2.5 (2012)	8-hour Ozone (2015); PM2.5 (2012)
	Vector control	--	--	Yes	Yes	Yes

While names of documents may vary among regions, the same type of document exists in each region for which text is indicated. (--) indicates not present. Data from relevant Regional Water Boards, Air Pollution Control Districts, and county codes.

Discussion

Aside from confirming the context-specific nature of environmental regulation, the trends discussed here are important to understand for future policy goals. It is common in agriculture, and particularly California dairy, for producers to describe a kind of regulatory fatigue which prompts them to either leave the industry (Sayre et al., 2012; Wilson, 2004) or relocate to a location with less stringent regulations (Isik, 2004; Sneeringer, 2011; Sneeringer & Hogle, 2008). In the case of California dairy specifically, producers facing new water quality regulations were even identified as undergoing stages of grief during workshops to introduce the new requirements (Meyer et al., 2019b). While some activists might cheer the idea of dairies closing up show (e.g., Luiz, 2020)— though the effects on households and communities should not necessarily be celebrated (e.g., Mollica, 2019)— when they move out of state any environmental problems are at best only shifted to a new location; more likely they are made worse if the new operation is able to emit more pollutants (Keske, 2019; Lee & Sumner, 2018). If this broader consideration of environmental impacts is important, then there is room for different, more flexible approaches to regulation outside of the classic command and control strategy that imparts top-down requirements and contributes to the regulatory fatigue described by industry participants.

This regulatory context identifies a use for new governance, where alliances and negotiation along with economic incentives take place of command and control strategies (Fiorino, 2006; Salamon, 2002; Salamon & Elliott, 2002). In the U.S., where there is a combination of low support for strong government and a general distrust between industry and government agencies (Davies & Mazurek, 2014; Moran et al., 2008), this approach is particularly warranted. Economic incentives have been used in past cases to motivate environmentally desirable actions (Dowd et al., 2008; Horan et al., 2002); they are more politically feasible and can be effective if a credible regulatory threat also exists (Dowd et al., 2008; Fiorino, 2006). Given the need to find a best fit between the motivations of regulatees and policy design (Potoski & Prakash, 2004), new governance approaches that incorporate economic incentives and emphasize public-private alliances are likely to be more politically feasible in the U.S. context (Fiorino, 2006; Salamon, 2002).

The previously mentioned Dairy Digester Research and Development Program (DDRDP) and Alternative Manure Management Program (AMMP) represent programs that meet this need. These programs implement components of new governance by offering grants to incentivize emissions-reducing infrastructure, and pairing producers with technical assistance providers who help submit grant applications. Table 6 identifies DDRDP and AMMP recipients in the profiled counties to date, as of October 2020.

Table 6. DDRDP and AMMP recipients in 5 counties

	Humboldt	Marin	Merced	Tulare	Riverside
DDRDP	0	0	10	33	0
AMMP	2	1	28	7	0

Data from California Climate Investment's Cumulative List of Implemented Greenhouse Gas Reduction Fund Projects (2020), and updated with October 2020 project awardees.

The numbers of grants received in Merced and Tulare counties reflect in part the larger number of operations there, as well as the suitability for anaerobic digesters. The presence of AMMP recipients—not to mention applicants who didn't receive funds—in four of the five profiled counties suggests broad interest in the voluntary program. Herrero et al. (2015) suggest that roughly only 10-20 percent of farmers adopt new sustainability practices over a decade, and thus what might appear to be low participation might actually be standard or even above standard participation levels when compared to farmer averages. The DDRDP and AMMP values in Table 6 are not strict representations of producers adopting new behaviors—at least some portion of the grant applicants are certainly implementing projects that resonate with other behaviors on their operations, and the list of final grant recipients does not capture the overall interest from producers. Additionally, it is as yet unknown if these voluntary projects will translate into desired outcomes for methane reduction, which is a crucial question for climate change efforts and public policy research broadly (A. Jordan et al., 2013). Nonetheless, the producer participation levels in these two programs stands as an indication that the new governance approach, when combined with an understanding of industry diversity, can effectively facilitate action to support policy goals.

Conclusions

This chapter discussed the presence and influence of diversity in California dairy operations, which is important for associated environmental initiatives. California's case offers useful insight for climate change mitigation policies more broadly, and in particular identifies the need for varied approaches that can utilize farm diversity while also providing resilience in the face of an unknown future. Lee and Sumner (2018) highlight that while state incentive programs can be valuable to reduce GHG emissions, it is risky for producers to depend on income from environmental policy incentives (they highlight credits for digester biogas specifically) as a component of financial stability; policy revenue is subject to technical changes, economic shifts, and political winds, meaning it could be eliminated or reduced by shifting trends. Keske (2019) emphasizes the need for systems thinking to address the range of options for GHG reductions, noting that across an entire system the accumulation of small improvements can add up. Both these suggestions lend support for a basic resiliency approach, such as an adaptive mosaic (Cork et al., 2005) of varied programs and infrastructure to address climate change which could both acknowledge the diversity of farming operations and offer greater protection against unknown futures. If a broad range of climate change mitigation strategies is implemented, even in the case where some options fail to deliver others will still provide results (and perhaps even exceed expectations). The dairy industry's experience during the Covid-19 pandemic in particular— in which dairy supply chains halted almost overnight and forced producers to dump milk while consumers saw empty grocery shelves— highlights the need for more diverse systems that are not optimized for highly specific conditions.

Chapter 3. Controlled by surplus: Lessons from California dairy's history

Introduction

Surplus production is a prominent trait of U.S. agriculture (Benson & Faminow, 1986; Cochrane, 1979; Johnston & McCalla, 2004), and is a defining trait of the post-war food regime(s) identified in food regime theory (Friedmann & McMichael, 1989; McMichael, 2009a; Messner et al., 2020). In dairy production specifically, the ramifications of surplus have been the impetus for most dairy-related legislation and frequently arise during legislative hearings (Hearing to Review the Economic Conditions Facing the Dairy Industry, 2009a; Horack & Cohen, 1934; Manley, 1949; Sonnich, 1934; Milk in California; Recommended Decision, 2017). Surplus production hurts producers' bottom lines by pushing their prices down (Horack & Cohen, 1934; Sonnich, 1934) and stands as an inefficient use of natural resources (Bolotova, 2014) if resources are used to create products that are not in demand. In dairy, as in other agricultural sectors, surplus is not an absolute state but is defined in relation to the amount of milk used for one class of products—in dairy it is fluid, or drinking, purposes—compared to other more processed classes of products (Blayney & Manchester, 2001; DuPuis & Block, 2008; Sonnich, 1934). Milk not used for fluid purposes is routed to the manufacture of cheese, butter, and powder products which can be stored for longer periods of time. Recent research highlights that these manufactured dairy products have been used to store surplus milk for millennia, as in the intriguing case of Irish butter preserved in bogs as far back as the Early Bronze Age (Smyth et al., 2019).

Supply management is one oft-cited means to address problems associated with surpluses. The overall concept is to control domestic supply so that it matches domestic demand, thus avoiding surplus or deficit swings and creating price stability (Duncan, 2003; Muirhead, 2014). Supply management has been used in various forms domestically and abroad, past and present, with commodities including milk (Bolotova, 2016; Graddy-Lovelace & Diamond, 2017; Muirhead, 2014). The approach has held an important— though under-acknowledged— role in U.S. agricultural policy (see especially Graddy-Lovelace & Diamond, 2017). Its modern policy role dates to the 1930s and the Agricultural Adjustment Act (AAA) of the New Deal, with dairy specifically being a part of the supply controls since the Steagall Amendment of 1941 (Schaffer & Ray, 2020; Winders, 2009). Supply management in the U.S. was meant to buoy farmer incomes, and this was achieved to some degree (Winders, 2009), but specifics of implementation also contributed to increased capital intensification (Cochrane, 1979, pp. 382–385) which is in many ways antithetical to the stated economic and environmental goals. Nonetheless, a well-designed supply management program provides something for everyone: consistent access to food supplies at a more stable price for consumers, as well as higher and more predictable incomes for producers (Bolotova, 2014; Schaffer & Ray, 2020).

While often discussed as an economic proposal, controlling the volume of agricultural production holds important environmental potential by stemming the incentive to continuously produce more (Duncan, 2003), spurred by the technological treadmill (Sanderson & Hughes, 2018). During its initial use in the U.S. in the last years of the Great Depression, supply management—and accompanying conservation requirements—was meant to address dual goals of economic and environmental stability. In addition to more stable prices for farmers and consumers, reduced production acreage was a means of stemming the soil erosion that led to the Dust Bowl (McGranahan et al., 2013; Olson, 2001). Increased financial security may also allow for more investment in sustainable agriculture practices and infrastructure (Duncan, 2003).

Despite supply management's relevance to the current moment for U.S. dairy, it has mixed support. A surge of new interest in supply management has come from dairy producers in particular, due to a spiral of plentiful supply and low prices (Nargi, 2018, 2020). Starting in 2018, several California dairy producer groups joined a national campaign to garner support for supply management (tactically termed Dairy Growth Management) in response to dire economic circumstances for the state's dairy producers (Wisconsin Farmers Union, 2020). Yet despite this momentum, during five years of research with the California dairy industry, variations on the following statement were common during interviews, conferences, and other industry gatherings: "The notion of supply management comes up cyclically, when prices are bad, but it will never pass" (Field Notes). This sentiment reflects the ebb and flow of support for supply management in U.S. agriculture broadly, as well (State of California Legislative Analyst, 1975; Winders, 2009).

Various American organizations have recently advocated for a well-designed supply management program in the U.S. today (Nargi, 2020; Schaffer & Ray, 2020; Wisconsin Farmers Union, 2020), though it is acknowledged as an uphill fight against neoliberal ideology (Muirhead, 2014). I analyze two collections of California dairy industry documents—supplemented by data from interviews and participant observation within the industry—to follow the treatment of dairy supply management as a concept throughout the years and to help understand the lingering bulwark against mention of supply management in many parts of the industry. Because the archive collections were curated and stored by dairy industry stakeholders, they give insight into the particular ways that industry actors think about dairy supply and its management. I first outline terms and the legal context to help clarify supply management as it is used in the U.S., and particularly within dairy production. Then I draw on content from the archives to illustrate the convergence of influences that were necessary to produce California dairy's complicated relationship with surplus and supply management. Lastly I identify lessons not just for supply management's path forward in this particular context, but for those who seek change in U.S. agriculture more broadly.

Supply Management in the U.S.

Supply management vocabulary is tricky, so some parsing and explanation is necessary before we go further. Supply management is a goal to balance production of a good with demand for that good, so as to avoid chaotic domestic supply swings; this should then stabilize producer incomes as well as consumer prices (Muirhead, 2014). Various approaches can be taken up to pursue this goal, and a key distinction exists between production-oriented supply management and post-production supply management (Bolotova, 2014, 2016). Production-focused efforts include acreage limitations which cap the amount of land used to produce a crop, or herd reduction programs which sell off animals to reduce the number of productive livestock. Post-production supply management could involve temporarily withholding commodities that have already been produced from market, or export subsidies to reduce domestic supply of a commodity. Supply management can be implemented by public or private entities, but the potential scope is different for these two groups. Due to the heavy influence of legal frameworks, I generally discuss the U.S. context here, only bringing in international examples for comparison purposes.

Public supply management

Under the Agricultural Marketing Agreement Act of 1937, public (government-run) supply management programs are possible at production and post-production phases (Bolotova, 2014). The U.S. had more robust production-focused public supply management for a range of commodities starting with the AAA in the 1930s, until the FAIR Act of 1996 took away production controls and associated price supports which gave farmers financial support if they limited production of a target commodity (Winders, 2009). After 1996 the focus of governmental supply management became post-production export subsidies, which had started in 1954 via Public Law (PL) 480 (Winders, 2009). Exports do not curtail domestic supply so much as send the domestic surplus abroad; while this technically addresses the domestic supply situation, it is a tenuous and potentially unsustainable situation dependent on the existence of export market outlets. It is important to note that supply management does not include programs popularly discussed under the banner of subsidies—for dairy, this has often meant Dairy Margin Coverage Program, Dairy Revenue Protection Program, etc.—which aim to support producer incomes without asserting any limit on production (Schaffer & Ray, 2020).

Private supply management

The act of industry competitors cooperating to control the amount of a good supplied to market is a cartel arrangement and thus violates the Sherman Antitrust Act of 1890; however the Capper-Volstead Act of 1922 gives limited exceptions to agricultural producers acting through cooperative organizations (Bolotova, 2014). Thus private supply management efforts through agricultural cooperatives are possible in addition to the sort of government-driven efforts exemplified in the AAA. Legal precedent for these groups limits the scope of supply control efforts, however, and recent interpretations of Capper-Volstead have allowed only post-production efforts such as withholding commodities from market to influence the price (Natzke, 2019; Peck, 2015). Production-oriented strategies from private organizations (cooperatives) are presently interpreted as violating the Sherman Antitrust Act of 1890.

Current forms of supply management

The public form of dairy supply management today exists via export subsidies and government purchase programs. The Dairy Export Incentive Program gives exporters of select dairy products subsidies so that they can compete with subsidized products from other countries; recipients submit bids based on negotiations with importers and if the U.S. Department of Agriculture (USDA) approves a bid they are provided with agreed-upon subsidy amounts after the sale takes place (U.S. Government Accountability Office, 1995). Government commodity purchases also serve to purchase dairy products in times of surplus and allocate them to domestic nonprofit entities, such as schools and food banks (Schaffer & Ray, 2020; USDA Economic Research Service, 2021).

Beyond public programs, private organizations (cooperatives) can exert supply management efforts by controlling the amount of already produced product that goes to market at a given time (Bolotova, 2016), which takes place via company-specific decisions as they deem it warranted by market conditions. While these efforts may help improve stability of prices for members, by law they must be post-production strategies only and they therefore do not influence overall markets away from oversupply. Thus the scope of their impact is limited. Cooperatives also utilize base-excess plans, which use pricing to incentivize producers to match seasonal demand. Base levels of production are allocated to producers, and any milk produced over that amount receives a lower price. However, the strength of this incentive depends heavily on the marginal production costs of individual producers (Michigan Farm Bureau, 2019); if an individual producer's cost to produce additional units of milk is below the overbase (excess) milk price, there may be little incentive to stick to their base production.

Schaffer and Ray (2020) show that critiques of U.S. supply management take a range of forms, and sometimes identify important areas of improvement: for instance the need for planting flexibility for farmers that was implemented in the 1996 FAIR Act, or the need for appropriate loan prices for commodity purchases. However, critiques most frequently identify ideological disagreements—particularly those based in neoliberal perspectives—and tend to stand apart from empirical data (Schaffer & Ray, 2020).

Past and present U.S. supply management programs famously contrast with Canadian supply management efforts, where domestic supply of covered commodities is determined via quotas allocated to producers (Benson & Faminow, 1986; Cardwell et al., 2015). The U.S. public has heard much criticism regarding Canada's supply management program, namely: Canada's high tariffs on imports (Northam, 2018) and the cost of the program being spread across consumers (Barichello et al., 2009; Cardwell et al., 2015; Hall Findlay, 2012). Yet experience identifies that benefits also exist, including that: smaller family farms are sustained, prices are stabilized, and the price of milk does not conceal hidden costs of government programs (Muirhead, 2014; Northam, 2018). Despite the heated rhetoric, there is clearly room for discussion about the costs and benefits of a supply management program.

Methods

Sources and data collection

This research relied most heavily on two historical datasets to investigate the trajectory of California dairy from the inside: the California Dairy Industry Historical Collection (CDIHC) housed by California State Parks, and a collection of dairy industry pricing documents housed by the California Department of Food and Agriculture (CDFA). Utilizing the two archives combined helped to highlight and thus limit the bias inherent to each collection due to its curators. The CDIHC was compiled by private dairy industry members initially for the purposes of establishing a California Dairy Museum. The pricing documents were compiled by the Dairy Marketing Branch of the state's agriculture department to serve as institutional memory of pricing policies and decisions. Both archives included legislative transcripts, pricing histories, industry newsletters, and oral histories that identified important changes and influences throughout dairy industry history.

In both archives, a large portion of the discussion of California dairy history comes from pricing hearing transcripts. These pricing hearings occurred regularly for almost a century because milk pricing has been highly regulated in California since the 1930s; regulation involved continual hearings (and associated transcripts) to discuss potential changes to prices. In these hearings dairy producers, processors, distributors, retailers, and consumers testified about their circumstances and gave insight into the ongoing events of the time. Their statements were clearly incentivized in particular directions (producers, for example, frequently testified about low prices and clearly hoped to gain pricing increases, which surely influenced their testimony); yet even with a particular bent, their statements are valuable insights into the evolving context of dairy production in California.

Analysis

Insights from informant interviews and participant observation during five years of research fieldwork with the California dairy industry helped structure my efforts in the archive collections. A small example can illustrate this point: two informants during my participant observation fieldwork identified the Dairy Termination (or "cow kill") Program of the mid-1980s as an important influence in producer attitudes about supply management. Identifying archive records that related to this program served to corroborate or challenge their analyses, as well as add additional insight into the history of supply management in

California dairy. The ability to "think laterally" (Jordanova, 2016; Vitalis, 2006) also helped identify additional documents which further explained the influence of the program—as well as thoughts about and responses to the program—on industry trajectories. Through these processes I identified almost 700 documents to review from the two collections, ranging from 1-300 pages each.

I utilized process tracing methodologies to reveal how the California dairy industry acquired its current orientation toward supply management. In process tracing, sequences of events are carefully described and interrogated in order to identify key mechanisms which contributed to the phenomena under study (Collier, 2011; George & Bennett, 2005). Process-tracing thus reflects the prominent role of mechanisms in social science research (Bennett & Checkel, 2012; Elster, 1989). George and Bennett (2005) discuss a form of process-tracing called *convergent colligation*, which seeks to understand the convergence of conditions, variables, or chains which created the outcomes under study. In this research I utilize the *convergent colligation* approach to process tracing and investigate the interplay between social, political, economic, and geographic variables. Additionally, I follow what Vanhala (2017) identifies as an "outcome explaining" application of process tracing, in which a combination of induction and deduction are used to give causal explanations for particular cases.

In line with the outcome explaining application (Vanhala, 2017), data were analyzed iteratively so that key processes were identified from sources through continuous review and comparison of data (Draucker, Martsolf, Ross, & Rusk, 2007; Fossey et al., 2002; Lincoln & Guba 1985). Analysis incorporated both inductive and deductive phases inherent to process tracing (Bennett & Checkel, 2012). To begin with an inductive phase, I used NVivo 11 Plus software to open code archive documents and identify emergent themes among different sources and categories. This process helped identify key events and the varying perceptions of them, as well as commonalities or conflicts connected to characteristics such as geographic location, production characteristics, etc. The coding scheme was continually revisited throughout the research process, to refine and develop categories as new data emerged. After an inductive phase suggested an explanatory theme or mechanism, I then turned to a deductive phase to interrogate the theory and seek out additional evidence to test the potential explanation's fit. Iteration between these inductive and deductive phases helped identify the most appropriate explanations for the ways that social, political, economic, and geographic variables contributed to the industry's perspective on supply and supply management.

Presentation

The iterative analysis process allowed the resultant narrative to be grounded in the available contemporary and historical data (Bernard, 2017). While archives have historically been viewed as neutral sources of information, they are specific, active collections that were curated most frequently to reinforce the positions of the curators (Derrida & Prenowitz, 1995; Schwartz & Cook, 2002). In the following analysis I refer to the use of archive documents regularly—rather than presenting quotes and summaries as disembodied from their institutional collection—as a reminder that the information presented is a specific representation, not an objective history. The archive documents that support narrative statements are identified in footnotes. Where possible documents are referenced with information that would allow the reader to track down the exact documents themselves regardless of archive location; for example, many of the cited documents are pricing regulation hearing transcripts, which are referenced with the date and short name of the hearing. For documents with less identifying information, the archive that housed the item is identified, along with archive location information and/or a description, as possible. CDIHC indicates the California Dairy Industry Historical Collection, which was curated with the goal of establishing a California Dairy Museum and is currently held by California State Parks at the Department Archives in Sacramento. CDFA indicates the collection of documents held for purposes of institutional memory by the Dairy Marketing Branch of the California Department of Food and Agriculture, before that branch was dissolved as a result of the state's shift to a federal milk marketing order in 2018. Due to curation methods for each collection as well as variability in events like pricing hearings, some decades are more thoroughly represented (such as the 1960s), and some documents include no dates.

Results

History of California's dairy supply

A close look at the perspectives captured by two industry archives identifies two prominent trends related to surplus production in California dairy. First, concern over a state of oversupply—in which an excess of fluid Grade A (market) milk specifically exists—is not new. Second, the current situation of California dairy—in which plentiful supplies of both conventional and organic market milk are tied to low producer prices that challenge dairy operations' viability—is a result of specific interacting circumstances.

Oversupply as a longstanding issue

The specific ramifications of an oversupply of milk are dependent on the marketing policies at the time, but in general these levels of supply lead to lower producer prices, and utilize valuable environmental resources for product that does not have an immediate home (Bolotova, 2014; Horack & Cohen, 1934; Sonnich, 1934). The exact extent of oversupply is difficult to measure, but in 2020 California dairy producers were told to cut their production levels by as much as 10-35% (Lee, 2020). While this had serious impacts on producers and their communities, historical documents also show this was a regular occurrence.

Oversupply, surplus, or excess milk as a concept was itself debated frequently in archive documents, particularly during pricing hearing testimonies. Indeed, there was regular representation from stakeholders that surplus conditions did not exist[3] because the milk was always put into some sort of use. Elsewhere California dairy surplus conditions have been traced back to 1806 (Graves, 1969 citing Roske, 1968), but pricing testimony on surplus circumstances dates to at least 1938[4] when a problem of surplus around Los Angeles was identified. Testimony from the 1960s identified the prevalence of milk surplus in California[5] and nationally[6], and an industry meeting speech from 1962 said solving the surplus problem was a matter of survival[7]. Some documents used surprisingly similar language: in 1966 an American Dairy Association annual meeting speech asked, "Dairy industry has been plagued with a long-run surplus. Need it be?"[8], and hearing testimony from 1974 identified Californians as having an adequate milk supply but being "plagued with constant excessive surpluses of market milk."

Over-supply has been a common difficulty in modern agricultural production broadly (Bolotova, 2014; Friedmann & McMichael, 1989; Messner et al., 2020), so in that sense dairy is not unique. Part of the specific difficulty for dairy lies in the nature of fluid milk as a highly perishable, regularly consumed product; in addition dairy itself has a "multiyear production cycle" (Johnston & McCalla, 2004) which means management changes generally

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[3] 1963 industry press release; 7-8 May 1974 Hearing on SR98 Relating to Marketing of Milk transcript; 12 Sept 1962 State Assembly Interim Committee on Livestock and Dairies (SAICLD) transcript; 26 May 1964 SAICLD transcript

[4] 12 Dec 1938 Proposed Plan for San Bernardino-Riverside transcript

[5] 14 Feb 1964 SAICLD transcript

[6] 22 July 1963 Amendments to Central Valley Stabilization and Marketing Plans transcript

[7] Remarks delivered at the 24th Annual Membership Meeting of the Protected Milk Producers Association Buena Park, California January 31, 1962

[8] Remarks delivered at the American Dairy Association Annual Meeting Chicago, Illinois March 23, 1966

take several years to have effect. Changes in demand in the near-term cannot be addressed by changes in production decisions, and as a result processing operations have used something once referred to as standby milk[9]. It denotes a reserve pool of milk available for fluid consumption (Class 1 products for which producers receive the highest price) in case of high demand, but which went to use in manufactured products (Class 2-4 products such as cheese, butter, and powder, for which producers receive lower prices) if not consumed (Cook, 1970). Given the tension and loaded meanings surrounding terms like surplus or excess, industry actors often took care to clarify the need for standby milk and define surplus around this need. Even this definition of surplus—one taking note of standby needs—was highly debated, but a common historical definition put forth by industry stakeholders put the standby volume of milk at 15-20%, and so production of milk greater than 115-120% of Class 1 (that is, fluid milk meant for drinking) demand was considered to be surplus.[10]

During surplus conditions, the effects spread to all producers regardless of their individual efforts to encourage or limit production[11]. Documents from the 1930s to the 1990s identified the impacts of surplus on producers, indicating it was a regular, persistent concern. They described more milk being used for manufactured products[12], for which producers receive a lower price. There was more difficulty marketing products[13], which resulted in more products purchased by the government's Commodity Credit Corporation (CCC) and held in

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[9] 22 July 1963 Amendments to Central Valley Stabilization and Marketing Plans transcript; 12 Sept 1962 SAICLD transcript; 26 May 1964 SAICLD transcript
[10] 22 July 1963 Amendments to Central Valley Stabilization and Marketing Plans transcript; 18 August 1962 "Dairyman" editorial; 15 Sept 1964 SAICLD transcript
[11] CDIHC document (n.d.): Series III, Subseries 1, Box 7
[12] 1 Nov 1955 Amendments to Assorted North Counties to Stabilization and Marketing Plans transcript; 7 May 1974 Report to Senate Ag and Water Committee transcript; 14 Feb 1964 SAICLD transcript; 26 May 1964 SAICLD transcript; CDIHC document (1964): Series V, Subseries 3, Box 20
[13] 1 Nov 1955 Amendments to Assorted North Counties to Stabilization and Marketing Plans transcript

storage until the market hit a specified release price[14]. In response to surplus conditions, lower market prices[15] and unfavorable contract changes with the creameries who handled their milk[16] put producers in even more precarious financial circumstances. Milk had to be shipped farther away for processing[17], or it was donated[18] (though this usually represents a very small percent, e.g., Messner et al., 2020) or even dumped[19] if it could not find a market.

A string of efforts to reign in surplus conditions also demonstrated the long timeline of surplus in California and U.S. dairy production. While marketing boards serve multiple functions, they are an important response to surplus supplies, as they reach out to consumers via marketing and education campaigns to encourage new outlets for milk. The California Dairy Council (now Dairy Council of California) was established in 1919 and the California Milk Advisory Board—housed under CDFA—which completes similar work was established in 1969. California Milk Advisory Board was perhaps most noticeable for their efforts starting in 2000 with the "Happy Cow" campaign (Drewniany & Jewler, 2011), not long after California took over from Wisconsin as the nation's top milk producer by volume. Two government-sponsored supply management programs of the 1980s—the Dairy Diversion Program and the Dairy Termination Program—respectively sought to reduce surplus by paying producers who reduced their production by a certain threshold, or by purchasing entire

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[14] 23 April 1987 prepared testimony; 12 Sept 1962 SAICLD transcript; 5 Dec 1995 Amendments to 4a-b Plans transcript; 8 Dec 1988 Hearing on Class 1-4 Prices transcript; 7-8 May 1974 Hearing on SR98 Relating to Marketing of Milk transcript; CDIHC document (n.d.): Series III, Subseries 1, Box 7-8

[15] 5 Dec 1995 Amendments to 4a-b Plans transcript; 8 Dec 1988 Hearing on Class 1-4 Prices transcript

[16] 1 Nov 1955 Amendments to Assorted North Counties to Stabilization and Marketing Plans transcript; 11 Sept 1962 SAICLD transcript; 4 Feb 1982 Carnation company letter regarding surplus milk handling

[17] 1 Dec 1994 Amendments to Class 1 Pricing transcript

[18] 12 August 1980 surplus donation letter (CDFA); CDIHC documents (1954 and n.d.): Series III, Subseries 1, Box 7-8

[19] 14 August 1980 letter regarding process for milk dumped by producer (CDFA)

herds for slaughter and imposing a 5-year embargo on those producers returning to the industry. Perhaps most recently, the 2003-2010 privately-run Cooperatives Working Together program also performed herd buyouts to reduce surplus conditions; however, because it was privately sponsored, the cooperative operating the program was sued and ended in settlement for Capper-Volstead violations (Natzke, 2019). These programs, taken in total, demonstrate the long-run difficulty of managing supply in California (and national) dairy production.

Today's oversupply: A result of overlapping trends

The technological treadmill—which pushes producers to take on more and more capital investment in technology in order to stay competitive with other producers who are also constantly updating their technologies—is often used to explain the industrialization of agricultural processes which contribute to and perpetuate surpluses (Cochrane, 1979; Johnston & McCalla, 2004; Sanderson & Hughes, 2018). Dairy producers have historically had particularly high capital investment costs, which contribute to continuous fixed costs (Thomas et al., 1997). A producer receiving low returns for each unit of milk due to low milk prices often perceived one main option to sustain the farm in the face of these regular bills: increase the number of units produced to try and meet fixed cost obligations[20] (Cochrane, 1979; Johnston & McCalla, 2004). This reflects a key mechanism in the technological treadmill described by Willard Cochrane (1979): low prices resulting from excess supply, often the result of new innovations in efficiency, trigger individual producers to manage for greater production volume[21] and effectively ensure oversupply in the future. While this treadmill incentive clearly applies to today's dairy producers in California, it must be

[20] 11 Sept 1962 SAICLD transcript; CDIHC documents: Series V, Subseries 3, Box 20
[21] 22 July 1963 Amendments to Central Valley Stabilization and Marketing Plans transcript; 18 August 1962 "Dairyman" editorial; 15 Sept 1964 SAICLD transcript

understood in context. Seeing today's supply struggles as coming solely from the technological treadmill misses the key supporting and amplifying mechanisms at play. Understanding these influences could help improve policy decisions—agricultural and otherwise— in the future. Four trends overlaid one another throughout the past century to steer the direction of today's California dairy industry and shape its relationship to surplus and supply management.

Layer 1: Different forms of production tied to distinct groups of settlers

California dairy history traditionally focuses on the contributions of three groups of European settlers: Italian-Swiss, Portuguese, and Dutch dairy producers all established different forms of dairy as a result of their familiarity with dairy in their home countries and the ecological/social circumstances of different parts of California. Before delving into their specific trajectories, it is important to clarify a point about geography: it would be easy to fall into environmental determinism and suggest that groups settled and developed where they did because the sites were naturally suited to their preferences. However, the reality is that groups settled in or moved to different areas because the previous inhabitants made them look a certain way, to greater or lesser degrees. These manicured changes made the land desirable to the incoming dairy producers and helped shape what kind of dairies were then established there. Landscapes throughout the state were managed by native peoples using fire to select for different vegetation needs (Agee, 2006), the Central Valley gained rich silt deposits via seasonal flooding before various engineering projects made it ideal for capitalist agriculture expansion, and Southern California was similarly transformed because of extensive water projects routing liquid gold from elsewhere (Reisner, 1993). It is on top of—and alongside— these changes that particular immigrant groups brought forms of dairy to California which have differentially contributed to today's high volume production landscape.

Italian-Swiss

Immigrants from the mountainous Italy-Switzerland border region were prominent in early California dairy (Hacken, 2020; Quinn, 2020), and documents collected for the California Dairy Museum frequently reference the Swiss as the "state's earliest dairymen"[22]. Like other immigrant groups to California many came initially because of the Gold Rush of 1849 (Miller, 1995), but after their mining interests died out quickly (Raup, 1951) many Italian-Swiss started producing dairy for the towns that had boomed into existence thanks to mining[23] (Edwards, 1949; Graves, 1969; Quinn, 2020).

The dairy operations run by Italian-Swiss were overwhelmingly located in rural areas (Quinn, 2020). They established dairies largely along the rural coastal hills where pasture dairies were possible, reflecting management styles they knew from back home[24]. The complications of transporting a highly perishable product before refrigeration technology necessitated that these dairies provided the Grade B (manufacturing milk) production for processed products rather than milk intended for drinking (Hacken, 2020; Raup, 1951; Sumner & Wilson, 2000). Thus throughout the coastal counties, Italian-Swiss producers became known for their quality cheeses and butter[25] (Hacken, 2020; Quinn, 2020; Raup, 1935, 1951). Today the demand for Grade B-specific production has dropped, but many of the rural coastal pasture operations contribute a different "other" market: the organic milk market which requires cows to be on pasture for a portion of the year (Digitale, 2016; Rinehart & Baier, 2011).

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[22] CDIHC documents (1977 and n.d.): Series I, Subseries 3, Box 2; Series III, Subseries 2, Boxes 8 & 10
[23] CDIHC documents (n.d.): Series III, Subseries 2, Box 8
[24] CDIHC documents (n.d.): Series III, Subseries 2, Box 8; Series III, Subseries 4, Box 2
[25] CDIHC documents (n.d.): Series III, Subseries 2, Boxes 8 & 10

Portuguese

Portuguese immigrants from The Azores islands have contributed heavily to dairy throughout California (Bohme, 1956; Regional Oral History Office, 2015; Von Kampen, 1977), though are most readily identified with the San Joaquin Valley[26] where they frequently constitute a majority of milk producers in a given area (Graves, 1969; Tate, 1974). Portuguese came to California early via the whaling industry, then as a part of the Gold Rush in 1849, and in successive waves after which were often supported by previous immigrants (Anderson, 1984; Baganha, 1991; Helzer & Machado, 2011; Warrin, 1997). Many Portuguese settled initially in the San Francisco Bay Area and then expanded to the Central Valley in the late 1800s (Miller, 1995). Graves (1969) identifies that a particularly large number of Portuguese came around 1900, and within 20 years many had moved from farmhands to dairy owners. This concentrated period of settlement and economic advancement is in part because the Portuguese had been working as shepherds (Warrin, 1997), but when wool markets declined rapidly at turn of century, they pivoted to a new and growing industry: dairy (Graves, 1969).

The Portuguese dairy producers had a reputation for working collectively with other Portuguese (Tate, 1974). Often they even chose to settle near others from the same families, villages, or islands, thus creating distinct 'islands' of Portuguese settlement and dairying throughout the San Joaquin Valley (Fujimoto & Sandoval, 2007; Graves, 1969). Their sustained presence in dairy is due in no small part to kinship networks that were utilized for dairying success (Baganha, 1991). An extension of this collective mindset was their important role in developing cooperative marketing arrangements[27]: they often established

[26] CDIHC document (n.d.): Series III, Subseries 2, Box 10
[27] CDIHC documents (n.d.): Series III, Subseries 2, Boxes 8 & 10

Portuguese cooperative creameries but also moved into non-Portuguese cooperatives, as well (Graves, 1969; Tate, 1974). Today Portuguese producers are still represented in dairy across the state (Regional Oral History Office, 2015) but are especially prominent in the high-volume dairy operations of the San Joaquin Valley (Library of Congress, 2010), and it is easy to hear Portuguese being spoken at industry meetings there (Field Notes).

Dutch

Documentation of Dutch immigration to California comes later than other groups; while Dutch immigration to the U.S. took place in the mid-1800s, many Dutch settled first in the Midwest and then migrated as groups to the West later in search of cheap land (Zwart, 2012). Dutch dairy producers came to the Central Valley in the late 1800s (Miller, 1995; Zwart, 2004), and Dutch settlement to the Los Angeles area specifically took off in the 1920s (Gilbert & Wehr, 2003). These immigrants from Holland—where space was at a premium—established the concentrated drylot form of dairying in the Los Angeles milkshed where space was similarly limited (Gilbert & Wehr, 2003; Surls & Gerber, 2016; Trombley, 1986). Producers had access to feed grown nearby from irrigated fields, enabling them to raise large dairy herds on small plots of land (Anderson & Boersma, 1962; Hart, 2003). These operations were suited for high volume production, and the Dutch therefore played a crucial role in the industrialization of dairy production that started in the Los Angeles area (Gilbert & Wehr, 2003). Strong Calvinist faith (Zwart, 2012) embedded a Protestant work ethic (Weber & Kalberg, 2001) in much of the Dutch dairy community, so that success in business has been interpreted as reward for their faith (Field Notes). Today they are prominent both in the large dairies that remain in Southern California and those spread across the Central Valley (Campbell, 2005; Hart, 2003; Von Kampen, 1977; Field Notes).

Interactions

The three groups identified above—Italian-Swiss, Portuguese, and Dutch—established their own forms of dairy production and influenced regional patterns of production. These forms are differently suited to contribute to oversupply concerns both past and present. Initially the Italian-Swiss in the North Coast and the Portuguese in the Central Valley were largely Grade B producers, with their milk going to manufactured products like butter or cheese. After processors started to use contracts to incentivize Grade B producers largely from the San Joaquin Valley to move into Grade A production[28], there was increased fluid milk oversupply that was most strongly noted by existing Southern California Grade A producers[29]. Today there is less attention on the distinction between Grade A and B producers (the latter have notably declined in number), and more on the conventional and organic markets. Conventional markets largely furnished by producers in Southern California and the Central Valley have been established for much longer and thus hit conditions of oversupply first, as discussed earlier in this paper. Organic producers—largely from the North Coast—are a recent addition and therefore reached a point of oversupply only recently (Lee, 2020)[30]. These past and present movements of regions around the problem of oversupply demonstrate how the historical immigration patterns—which strongly influenced regional forms of dairy—continue to have ramifications today.

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[28] 7 May 1974 Report to Senate Ag and Water Committee transcript; 29 June 1960 SAICLD transcript; 26 May 1964 SAICLD transcript; 11 Sept 1962 SAICLD transcript; 17 Sept 1965 Hearing on Brucellosis and Milk Stabilization transcript; 1 Nov 1955 Amendments to Stabilization and Marketing Plans transcript; 22 July 1963 Amendments to Stabilization and Marketing Plans transcript

[29] 18 April 1991 Transportation allowances hearing transcript; 7 May 1974 Report to Senate Ag and Water Committee transcript; 14 Feb 1964 SAICLD transcript; 26 May 1964 SAICLD transcript

[30] This latter occurrence of surplus occurred in part because more producers were drawn to organic for the price premiums, and also because its niche production mode means a more nationally-centralized corporate structure so supply competes more broadly (Diamond, 2013).

Layer 2: Pricing regulations set to ensure an adequate supply of milk

Milk is produced daily and cannot be stored for long on-farm, so producers need an arrangement with a handler to offload milk regularly (every 1-2 days); as a result producers have little bargaining power in their contract arrangements. This power disparity was particularly enflamed during the early 1930s in what were deemed “milk wars”, when California distributors cut sales prices of milk drastically to appeal to consumers in the midst of the Great Depression. Many producers fought back to try and regain prices that could sustain their operations; the situation got heated and at one point industry members appealed to the governor to send in the National Guard to maintain order, but this step was never taken (Kuhrt, 1965). Since milk was characterized early on as a food important to public health—a measure not unique to the U.S. (Muirhead, 2014)—and since its perishability created clear power imbalances between producers and processors, demand grew for contract and pricing regulations to inject stability into dairy production (Manley, 1949).

Following from the tumult of the milk wars in the early 1930s, two pieces of legislation dubbed the California milk laws were enacted to stabilize milk prices. Through the Young (1935) and Desmond (1937) Acts, dairy industry pricing and contracts in California were regulated. These milk laws called for prices to be set that would "cover the costs of production" and "bring forth an adequate supply" of milk (State of California Legislative Analyst, 1975). As various authors have written about the complicated pricing structure: business-minded dairy operators could look at the guidelines and find several rationales for growing production levels, particularly as a means of taking advantage of class pricing (McCorkle, 1961; Pelissier, 1968; Sumner & Balagtas, 2002).

After initial attempts to regulate pricing via the Young and Desmond Acts, disparities in producer contracts—specifically how much of the highest-priced Class 1 allocation each producer received—led to the Gonsalves Milk Pooling Act in 1967. This legislation included a number of compromises to garner the requisite support in the legislature and the subsequent producer referendum (Sumner & Wilson, 2000). Perhaps the most famous compromise was quota, which functions differently than quota elsewhere. It garnered producer votes in favor of the bill by issuing quota allocations that guaranteed a higher price for a certain portion of producers' milk based on historic production. Additionally, price differentials were put in place to incentivize moving quota milk into "milk deficit" (i.e., metropolitan) areas of the state (*Transportation Allowances and Credits*, 1991; State of California Legislative Analyst, 1975). These components were decided upon during a time when the state's population was growing and concern was focused on meeting future needs for fluid milk (Milk in California; Recommended Decision, 2017), but subsequent demand did not live up to expectations (State of California Legislative Analyst, 1975).

The milk laws created regulation of milk prices as a means to institute stability and ensure an adequate supply of milk, but these policies that sought to create a minimum volume of milk existed alongside other policies that prohibited efforts at capping the volume of milk. Capper-Volstead interpretation at the federal level prevented private cooperatives from limiting production volumes (Natzke, 2019; Peck, 2015). At the state level, California Food and Agriculture code prohibited the state's agricultural department from controlling agricultural production volumes (Sumner & Wolf, 1996). Simultaneously, federal price support programs encouraged levels of production beyond market demand, and the surplus volume was then purchased by government as manufactured dairy products (cheese, butter); surplus was encouraged but producers were buffered from the effects of surplus at some level (Benson & Faminow, 1986). Thus the milk laws that were instituted to protect producers from processor manipulation, alongside state and federal codes and policies, in various ways laid the groundwork for subsequent surplus issues. State and federal policies collectively provided institutional mechanisms of support and incentives for increased production, as well as hurdles to supply management mechanisms that might stem the increase. The milk laws reflect concern about shortage but appear to have brought about excess.

Layer 3: Urbanizing milksheds and specific tax incentives

In addition to immigration patterns and pricing policies, trends of urbanization played a key role in increasing supply of dairy products in California. Prior to the development of refrigeration capacity, dairies were located in close proximity to cities to supply the population with milk (Block & DuPuis, 2001; Von Kampen, 1977; von Thünen, 1826). As cities grew so did land and labor costs of producing in metropolitan areas (Fletcher & McCorkle, 1962). Additionally, residents did not want to live in close proximity to dairies (Von Kampen, 1977) so they created environmental and/or zoning laws to push them out[31] (Campbell, 2005; Hirsch, 2006; Shultz, 2014; Sneeringer, 2011; Sneeringer & Hogle, 2008).

This trend played out in various times and places across California. San Francisco's Cow Hollow area is so named because of the dairies there that supplied the growing city in the 1800s, and Los Angeles once had dairies where it now hosts Chinatown and Wilshire Boulevard[32]. The urban growth of the 1950s saw dairy operations from San Diego to the San Francisco Bay Area pushed farther into exurban or rural areas[33] (Topics, 1957). The general trend of this movement is commonplace, but the specifics of how it played out in the Los

[31] 1 Dec 1994 Amendments to Class 1 Pricing transcript; CDIHC documents (1979 and n.d.): Series II, Box 6; Series III, Subseries 2, Box 8
[32] CDIHC documents (n.d.): Series III, Subseries 2, Box 10
[33] Remarks delivered at the American Dairy Association Annual Meeting Chicago, Illinois March 23, 1966; 1 Nov 1955 Amendments to Assorted North Counties to Stabilization and Marketing Plans transcript

Angeles area at the end of the 20th century are pivotal for California dairy broadly (Hirsch, 2006).

In the immediate post-World War II era in Southern California, residential development skyrocketed and pushed dairies to outlying areas of Los Angeles into the Inland Empire (Anderson & Boersma, 1962; Campbell, 2005). Then in these areas too, development crept in and the land values of dairies increased to the point where by the 1980s to early 2000s, selling the land was a logical step for most producers (Anderson & Boersma, 1962; Gilbert & Wehr, 2003; Hart, 2003; Surls & Gerber, 2016; Von Kampen, 1977). Many dairies then relocated to the Central Valley (Campbell, 2005; Hirsch, 2006), while others moved out of state or retired.

Amidst these successive relocations, tax code (specifically what is referred to as a 1031 exchange) played a crucial role. Internal Revenue Service code section 1031 defers capital gains taxes from a sale when “like-kind” properties are exchanged, so it incentivized dairies to re-invest profits from the sale of their urbanizing land and purchase (generally larger) plots of land for new dairies (Hart, 2003). As dairies looked to purchase larger amounts of land for new dairies, the Central Valley was enticing because land was cheap and there were fewer geographic or regulatory hurdles (Sneeringer, 2011) to creating large operations on which they could expand, produce their own feed, and/or diversify. This section of tax code combined with the urbanization effect facilitated establishment of larger dairies in a lower cost area—the Central Valley—which now constitutes the vast majority of California dairy production (California Department of Food and Agriculture, 2014).

Regional variations

A parallel between urbanizing milksheds in the San Francisco and Los Angeles areas demonstrates how site-specific conditions influenced the overall trajectory of California dairy operations as they shifted away from metropolitan areas. As the San Francisco Bay Area sprawled and development pressure increased, land trusts in Marin and Sonoma Counties in the 1970s and 80s began to utilize agricultural easements to buy development rights and keep land from being developed (Marin Agricultural Land Trust, 2021; Pranka, 2014; Sonoma Land Trust, 2021). To remain economically viable, dairies in this North Bay area doubled down on the pasture mode of production suited to their topography, climate, and access to feed resources (Guthey et al., 2003), which allowed them to capitalize on organic and artisanal branding. Producers in the North Bay region are better able to survive on pasture production in part due to their proximity to the consumer markets of nearby San Francisco (Pranka, 2014).

Starting earlier in the 1950s (California Planning & Development Report, 2002; Von Kampen, 1977), dairies in the greater Los Angeles resisted development pressures by utilizing agricultural zones that offered reduced property taxes via the Williamson Act, if farmers agreed not to develop their land for ten years (Onsted, 2010; Trombley, 1986). They also doubled down on the concentrated drylot mode of dairying that is suited to their topography, climate, and access to feed via Los Angeles ports and the Imperial Valley with its Colorado River irrigation water. However, this mode of production does not command a price premium like the pasture production that North Bay dairies could utilize. Despite efforts to resist development via the Williamson Act, Southern California dairies followed a pattern of leapfrog migrations that eventually led to the shift into the Central Valley described above.

While the San Francisco and Los Angeles areas are not directly comparable given various social, climate, and topography differences, a comparison between the two highlights important tools in open space preservation: as the Marin-Sonoma area made use of permanent agricultural easements, the Los Angeles area used Williamson Act declarations which can be revoked and are found to be relatively ineffective in metropolitan areas (Onsted, 2010). Additionally, the North Bay dairies could utilize pasture methods that brought in higher prices to help weather increased operational costs, while the drylot method of Los Angeles dairies did not bring price premiums. A combination of geography and policy tools explains much of the variation in dairy conservation seen between Los Angeles and San Francisco exurban areas (Gilbert & Wehr, 2003; Guthey et al., 2003).

Layer 4: Universities facilitate higher volume production

Less frequently acknowledged, though still key, is the role of university research—particularly cooperative extension work—in increasing productive capacity for California dairy. This parallels experience in other agricultural industries and places where university resources have encouraged productionist approaches and focused on increasing output (see discussions in Hassanein, 1999; Henke, 2008; Hightower, 1973; Johnston & McCalla, 2004). One of the earlier examples is the support of dairy cow test associations. These cow test associations took regular, detailed records of dairy cow milk production (including milk weight and component measurements) to help improve production. The Ferndale Testing Association in California was established in 1909[34], and just a few years later boasted improved cow production numbers and praise from University of California faculty ("Work of the Ferndale Cow-Testing Association," 1913). In 1920 University of California Cooperative Extension launched a major campaign to implement dairy cow test associations across the state and educate farmers about management techniques[35]. Herds enrolled in Dairy Herd Improvement Association (DHIA), a national program started in 1906 to improve dairy management and genetics through large volume agricultural record-keeping (Dickinson,

[34] CDIHC document (n.d.): Series III, Subseries 2, Box 10
[35] CDIHC document (1976)

1984). DHIA herds submit monthly data to the program, which has frequently been managed at various levels by state agricultural colleges and departments (Ferris, 2006). Producers from the north to the south of California credited cooperative extension and the test associations for improving dairy herd yields (Topics, 1957), and in the 1970s California's DHIA herds boasted 30-40% more production than non-DHIA herds[36]. Newspaper clippings about retiring dairy industry actors frequently cited their accomplishments with test associations and the production results that came from breeding improvements.

The University of California system was clearly pivotal in supporting the dairy industry's trajectory to higher volume production. The system began instruction in dairy at Berkeley in 1879, and then shifted to Davis in 1908 where the university farm included a creamery[37]. The impetus to build an agricultural college in California (what became the University of California, Davis) even came from California dairyman Peter J. Shields[38]. The employment and development of agricultural experts in these institutions was a key component in the industrialization of agriculture broadly, and the persistent focus on efficiency prompted higher volume production and subsequent surpluses (Fitzgerald, 2003). Dairy was no exception to this trend. University research and personnel contributed the means—and thus the pressure—for increasing production per dairy cow, and per dairy operation.

Ideology and Power

The surplus problems exhibited throughout California dairy history are supported by multiple, complex processes, as described in the previous section. Yet the problems are also

[36] 1 Nov 1955 Amendments to Assorted North Counties to Stabilization and Marketing Plans transcript; CDIHC document (1976 and n.d.): Series III, Subseries 2, Box 8
[37] CDIHC documents (n.d.): Series I, Subseries 6, Box 5
[38] CDIHC documents (n.d.): Series III, Subseries 2, Box 10; Series III, Subseries 4, Box 11

the sort of thing supply management—particularly *production*-focused supply management—has been show to remedy (Bolotova, 2014; Duncan, 2003; Muirhead, 2014). Why is supply management not more readily supported, given the long history of pain from oversupply? It is possible that federal (Capper-Volstead) and state (CDFA) limitations on production-based supply management could be a driving factor against industry support; instituting it would require changing or circumventing legislation. Yet in practice, the rhetoric about supply management almost never indicates an understanding of these specific policy hurdles. Instead two important factors frequently arise as the source of a lack of industry support: cultural ideologies of producers and the power of processors.

American Dream ideology

Throughout the industry archives and other industry representations, producers frequently presented a self-conception as hard-working descendants of immigrants who aimed to work tirelessly and produce efficiently so that they could support themselves and their families; what is often, in modern conception, characterized as the American Dream narrative (Gullette, 2001; Rowland & Jones, 2007). This follows from the industry origins identified earlier: California dairy began as a European settler industry and these histories established the forms of dairy that exist today. Roots in immigrant origins continue to be an important component of identity and self-perception for the industry, and foreground the emphasis on (independent) hard work and efficiency.

Industry stories and documents lauded the value of hard work and elevated the status of dairy producers because of their labor. They frequently drew on the importance of cattle to early western pioneers[39], and celebrated the contributions of immigrants[40] and individuals who appeared to pull themselves up by their bootstraps. This perspective celebrated hard work as virtuous and honorable[41] (see another agriculture industry parallel in Shelton & Eakin, 2020), with producers identifying their lot as "a rough life, but a good life"[42]. Producers frequently referenced the long hours that dairy producers had to work[43] with little to no opportunity for a break or holiday, and suggested that the grueling schedule prevented others from engaging in the business.[44]

Such narratives based on sweat and self-sufficiency—calling back to conceptions of industrious pioneers[45] who laid a foundation for modern California—prompted producers to reject legislation such as the milk laws and others attempts to manage overall milk supply[46]. The emphasis on hard work, independence, and efficiency undergirded a tendency towards free market ideology, often advanced by industry groups like the Farm Bureau[47]. The individualist perspective often prevented any sort of collective action on the part of producers, even where it might have been beneficial (Cochrane, 1979; Dupuis, 2002).[48] One quote got straight to this point: "The trouble with you dairymen is that you can't get together. The only time two of you can get together is when you are six feet under the ground."[49]

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[39] CDIHC documents (1932 and n.d.): Series I, Subseries 3, Box 2; Series III, Subseries 1, Box 7

[40] 9 August 1996 Hearing on Class 1 Formulas transcript; 15 Sept 1964 SAICLD transcript; CDIHC documents (n.d.): Series III, Subseries 2, Box 10

[41] 1 Dec 1994 Amendments to Class 1 Pricing transcript; CDIHC document (1932): Series III, Subseries 1, Box 7

[42]CDIHC documents (n.d.): Series III, Subseries 2, Box 8

[43] 9 August 1996 Hearing on Class 1 Formulas transcript; April 1961 Amendments to Fluid Milk Retail Prices transcript; CDIHC documents (n.d.): Series 1

[44] 9 August 1996 Hearing on Class 1 Formulas transcript; CDIHC documents (1952 and n.d.): Series II; Series III, Subseries 2, Box 8

[45] CDIHC documents (1977 and n.d.): Series I-III

[46] 11 Sept 1962 SAICLD transcript; CDIHC document (1953): Series II, Subseries 1

[47] 25 Sept 1963 Amendments to Fluid Milk Retail Prices transcript; 12 Sept 1962 SAICLD transcript; CDIHC documents (1963 and n.d.): Series III, Subseries 1, Box 8

[48] CDIHC document (1984): Series III, Subseries 1, Box 7

[49] CDIHC document (1978): Series III, Subseries 1

These individualist themes arise in historical documents but also continue through today, particularly in response to public policy that bends towards communal management. One snapshot of this is a 2009 hearing of the House Committee on Agriculture, prompted because of the dire conditions facing the U.S. dairy industry at the time of the Great Recession (Hearing to Review the Economic Conditions Facing the Dairy Industry, 2009a). Here, even during a period of severe financial hardship—in which supply management is said to appeal to more producers (State of California Legislative Analyst, 1975)—the clear majority of stakeholders questioned said they opposed supply management, giving justification based in free market principles. They suggested that "…any market intervention to that scope will end in tears" and repeated the idea that supply management "stymies production" which runs counter to the goal of open competition. In contrast, the few voices in favor of supply management emphasized the value of collective decision-making and the harm that comes from volatile free market prices. Clearly a cultural emphasis on individualism and free market principles has been a key factor in the rejection of supply management (Hearing to Review the Economic Conditions Facing the Dairy Industry, 2009a).

Power of the middlemen

In the dairy industry producers have had a tense history with the entities that process and distribute dairy products, which encouraged and perpetuated suspicion about how such middlemen used their power in the industry. Stories of past manipulations—including excessive charges, requirements to produce over-contract, or insistence on utilizing specific vendors[50]—combined with the powerful position processors and distributors held in the

[50] 7 May 1974 Report to Senate Ag and Water Committee transcript; 11 & 12 Sept 1962 SAICLD transcripts

industry made various stakeholders question the role processors and distributors played in surplus situations.

Stakeholders, particularly producers, often referenced past contract manipulations that led to legislation like the milk laws of the 1930s when they expressed distrust of processors[51]. Producers through various decades said that even with the milk laws in place, processors still treated them poorly in their business relationships and threatened cancellation of contracts[52]. From the producer perspective contracts generally represented undesirable, unilateral (or at least, dominant) exertions of power from processors and distributors (Horack & Cohen, 1934). Yet at the same time producers were financially dependent on keeping a contract and it was difficult to find a new one if a processor cancelled the existing contract[53]. As an illustration of the extreme lengths producers would go to acquire contracts, legislation was brought forward to end the practice of producers giving "loans" to processors and distributors in order to secure favorable contracts[54]. Given this context, producers frequently avoided doing anything to jeopardize their existing contract relationship; they often refused to testify about the inequities at state hearings or even to a judge in private[55].

Industry actors saw that processors and distributors had an incentive to keep production volume high and thus milk prices low, because they used raw milk supplies to create their end products (Davidson, 1996; Horack & Cohen, 1934; Schaffer & Ray, 2020). Particularly in the 1960s and 1970s, processors were accused of intentionally creating surplus

[51] 15 Nov 1956 Amendments to Fluid Milk Retail Prices transcript; 7 May 1974 Report to Senate Ag and Water Committee transcript
[52] 15 Sept 1964 SAICLD transcript; 8 Dec 1988 Hearing on Class 1-4 Prices transcript; 9 August 1996 Hearing on Class 1 Formulas transcript; CDIHC document (n.d.): Series III, Subseries 1, Box 7
[53] 14 Feb 1964 SAICLD transcript; 11 Sept 1962 SAICLD transcript; 7 May 1974 Report to Senate Ag and Water Committee transcript; CDIHC document (1978): Series III, Subseries 1, Box 8
[54] 4 Oct 1961 SAICLD transcript; 11 Sept 1962 SAICLD transcript
[55] 7 & 8 May 1974 Report to Senate Ag and Water Committee transcript

conditions so they could have plentiful, low-cost raw materials for their processed dairy products[56]. This pattern of behavior and subsequent allegations came in part due to reduced supplies of Grade B milk[57], thought the intricacies of Grade A and B supplies get messy. Yet even stakeholders who sympathized with the processor/distributor situation stated that by the 1970s they were controlling producers via their contracts as an “instrument of peonage” which gave processors/distributors “power of life or death” over producers[58]. Processor representatives denied the accusations[59].

In the 1980s and 90s, California’s make allowance—which aims to give processors and distributors a return on investment (Cross, 2006; Jesse, 1994)—was a point of focus for those concerned with halting surplus conditions. The make allowance in California was a fixed amount of money applied to the price of dairy products, which was intended to cover manufacturing costs for processors (CDFA Milk Stabilization Branch, 1988). The California make allowance was infamously larger than make allowances elsewhere in the country and ensured the California processors received larger profit margins (Jesse, 1994). By ensuring such profits to processors, the make allowance paved the way for California processing capacity expansion[60] (Cross, 2006). Critics suggested that California’s dairy processing capacity not only grew to handle the state’s growing production volume, but the expanded processing capacity actually started to demand greater production levels itself[61] because the

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[56] 15 Sept 1964 SAICLD transcript; April 1961 Amendments to Fluid Milk Retail Prices transcript; 14 Feb 1964 SAICLD transcript; 11 Sept 1962 SAICLD transcript; 7 & 8 May 1974 Report to Senate Ag and Water Committee transcript; 29 June 1960 SAICLD transcript; 26 May 1964 SAICLD transcript; 18 August 1962 “Dairyman” editorial

[57] 7 May 1974 Report to Senate Ag and Water Committee transcript

[58] 17 Sept 1965 Hearing on Brucellosis and Milk Stabilization transcript

[59] 14 Feb 1964 SAICLD transcript

[60] 5 Dec 1995 Amendments to 4a-b Plans transcript

[61] 8 Dec 1988 Hearing on Class 1-4 Prices transcript

make allowance buffered it from market signals (Hearing to Review the Economic Conditions Facing the Dairy Industry, 2009b; Jesse, 1994)[62].

Historically, California contributed substantially to the U.S. supply of processed dairy products (Paggi et al., 2014), so processors could see substantial gain by encouraging surplus production and keeping input costs low. At the very least processors and distributors had little reason to use their significant lobbying power[63] to reduce surplus conditions. Surplus conditions kept prices paid to producers low, but processors also used their political power to try and keep them down during milk pricing hearings[64]. Once pricing relationships were established, vested interests in the status quo often kept them from changing too drastically[65] (Fletcher & McCorkle, 1962), which served to entrench gains made from pricing hearing decisions.

Processors and distributors are not all lumped into a cohesive category, however. Cooperatives hold the specific status of producer-distributors, which historically gave them a confusing identity that fluctuated depending on circumstances[66]. The 1967 Gonsalves Milk Pooling Act and subsequent related amendments exempted producer-distributors (which covers cooperatives) from some pricing regulations[67] (Kuhrt, 1972), allowing some

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[62] Arguments regarding pricing and the make allowance get particularly muddy. One defense of the processors' position exemplifies this by arguing in a circle that low prices (which often prompt future surpluses) are necessary so that creameries can process as much of the surplus conditions as possible: "A low raw product cost allows California creameries to handle the maximum amount of surplus milk possible. Given today's level of excess production--we need every bit of creamery capacity available in order to prevent dumping." (Siebert, 1982)

[63] CDIHC documents (n.d.): Series III, Subseries 1, Box 8

[64] 15 Dec 1995 Amendments to Class1-3 Price Formulas transcript; 9 August 1996 Hearing on Class 1 Formulas transcript

[65] 1 Dec 1994 Amendments to Class 1 Pricing transcript

[66] 26 May 1964 SAICLD transcript; 8 May 1980 Meeting of dairy industry leaders summary document

[67] 9 August 1996 Hearing on Class 1 Formulas transcript; 8 Dec 1988 Hearing on Class 1-4 Prices transcript; 15 Dec 1995 Amendments to Class1-3 Price Formulas transcript

cooperatives to use their exempt status to encourage surplus milk[68]. Additionally, status as cooperatives (or "producer-distributors") made it easy to reject any pricing change that took money from processors as also taking money from producers.[69] The cooperative structure—in which producers are member-owners who have some means of voting on cooperative actions—is lauded for its emphasis on producer representation, but many suggested that dairy cooperatives had taken on identities as processors and not producers. And yet, the cooperative-based supply management program (Cooperatives Working Together) was sued for Capper-Volstead violations by plaintiffs—including large retailers and buyers of dairy products—who sought to prevent the cooperatives' efforts to stem surplus conditions (Bolotova, 2014; Natzke, 2019). Cooperatives clearly sat in a difficult in-between area as both producers and processors, but their circumstance illustrates how powerful middle actors in the industry were often disincentivized from supporting supply management that could stem increased production and its attendant problems.

Discussion: What to do with dairy? Key hurdles on the path to supply management

Oversupply has been a continuous, defining trait of U.S. agriculture broadly (Graddy-Lovelace & Diamond, 2017; McMichael, 2009b) and California dairy specifically, as demonstrated in previous sections. While supply management is often discussed as an economic proposal to stem the price volatility of oversupply situations, it holds important potential to simultaneously promote environmental quality, as well (Duncan, 2003). Thus a range of interest groups could find shared interest in supply management programs which counter the pull of the technological treadmill for dairy production; these include

[68] 26 May 1964 SAICLD transcript; 14 Feb 1964 SAICLD transcript
[69] 5 Dec 1995 Amendments to 4a-b Plans transcript

environmental and rural community advocates, as well as more traditional agricultural groups. Attempts to institute supply management policies in California dairy need to address a range of factors supporting the current (continuing) surplus situation, with its accompanying impacts.

Before getting to the mechanisms of oversupply, however, there is an important point about the settler legacy of California dairy that should be addressed. The immigration patterns of California dairy outlined earlier indicated that milk has been overwhelmingly produced by populations perceived as white, even though these groups likely faced other forms of discrimination based on national, ethnic, or religious identities (Fox & Guglielmo, 2012). This is key given the historical discrimination against BIPOC (Black, Indigenous, and people of color) farmers in the U.S., particularly around land access and inclusion in USDA lending programs (Bilecky, 2019; Carpenter, 2012; Ginapp, 2003; Graddy-Lovelace, 2017; Tyler & Moore, 2013). Farmers and ranchers in the U.S. can only survive with access to loans in the appropriate amount at the appropriate time (Carpenter, 2012). The prominence of white producers in dairy means that the agricultural resources and programs—specifically agricultural credit via lending programs—which were necessary to establish a capital-intensive operation like a dairy were more or less accessible to these producers, whereas the resources were not generally accessible to BIPOC farmers.[70]

Additionally, milk as a commodity in California has been supported by legislation deeming it important to public health. It is worth noting that milk itself is not enjoyed equally by all persons, and that many ethnic groups exhibit high degrees of lactose intolerance,

[70] It is important to simultaneously acknowledge the history of discriminating against immigrants, particularly those who may have been deemed white but still considered by some to be racially inferior, e.g., Southern Europeans like the Italian and Portuguese dairy producers described here (Fox & Bloemraad, 2015).

though least in certain north European, North American, and Australasian groups (Lomer et al., 2008). That milk was deemed such a publicly important good is an indication to some degree of its nutritional value (particularly for young children), but it also shows the perspective of those in power to shape public policy: it shows that their lens on nutrition was skewed to preferences of certain largely white populations. Thus whiteness and its trappings has shaped the trajectory of California dairy, particularly in its ability to be publicly protected. A document found in the collections for the proposed California Dairy Museum—a conference paper presented in 1923 by a member of the California Dairy Council—makes this historical influence abundantly clear: "To humanity in general, you render a high service, for dairy products are the essential food- as Herbert Hoover says, "The White Race Cannot Survive Without Dairy Products."" [71] If there is to be an inclusive coalition of advocates supporting supply management for California or U.S. dairy, this history needs to be acknowledged and addressed.

Shifting back to the need to address extant circumstances supporting surplus dairy conditions, the first target is pricing regulations, which include the goals to ensure adequate supplies of milk for the public and cover costs of production for producers. These targets—combined with state and federal prohibitions against production-based supply controls—lead to an environment in which there is a minimum floor for milk production but no ceiling; surplus logically follows. Instituting supply management would require legislation that allows for production-based supply control, and which does not put cooperatives at risk of Capper-

[71] The paper was originally presented by Robert E. Jones of the California Dairy Council, before the Conference on Land Settlement, University of California, Berkeley, February 5-9, 1923. A copy of the presentation appeared as an article in the February 1923 edition of the Sugar Beet Journal, p. 7-8. It was titled "The Dairy Cow- Foster Mother of Mankind", with a subtitle "Safety in Colonization". CDIHC document (1928): Series I

Volstead violations as with the Cooperatives Working Together program (Natzke, 2019; Peck, 2015).

A second factor is the effects of urbanization on land values, particularly when combined with the tax incentives of 1031 exchanges. It is possible that exurban land sales could continue to happen and facilitate development of even larger dairies, further consolidating the industry. While it may not be possible to curtail this trend, an important focus in slowing it could be more land trust work, particularly in the Central Valley. Since Williamson Act declarations are revokable (as seen in the Southern California cases described here), land trust purchases of development rights are a more reliable means of preserving working lands (Onsted, 2010; Trombley, 1986). The California Climate Action Network (CalCAN) recently identified a need for more permanent protection of agricultural land in the Central Valley specifically (Merrill, 2020).

A third factor is the cultural norms and ideas around supply management, which clearly follow the food regimes framework (Friedmann & McMichael, 1989; McMichael, 2009b; Tilzey, 2019) in which supply management ideas were supplanted by free market principles (Graddy-Lovelace & Diamond, 2017). Supply management as a concept has become a focal point for neo-liberal tensions (Muirhead, 2014; Schaffer & Ray, 2020), and cultural norms and political ideologies have become inextricably entwined in the rhetorical and political battles. Advocates for supply management are unlikely to change entrenched ideas, but support from within the dairy industry—including affiliate partners—can be valuable for accepting change (Runhaar et al., 2020). Additionally, there is opportunity for universities to play an important role here. In the past, university resources—particularly agricultural engineering departments—were key in developing technologies to facilitate increased production in dairy and other industries (Fitzgerald, 2003; Henke, 2008;

Hightower, 1973). Universities could instead use a range of natural and social science research to help facilitate shifts towards production systems geared not towards maximum production, but in support of sustainable production that supports rural communities, business interests, and consumers. Farmer knowledge-sharing networks offer important examples of what this support can look like (Bell, 2010; Hassanein, 1999).

The last major factor this paper identifies as spurring surplus production is the lack of processor incentive to support supply controls. The power of middlemen in dairy parallels the concentrated power of processors and distributors in food industries broadly (Howard, 2016). In addition to this broader problem, for dairy a major sticking point is the prevalence of cooperatives who are made up of producer members, but also serve as processors. To the extent that changes to dairy marketing and/or pricing policies are subject to referendums, and if cooperatives can block vote for their members as they did with the 2018 federal milk marketing order vote (Bechtel, 2018), this could remain a crucial roadblock to future supply management efforts. As Benson & Faminow (1986) identified: "…middlemen interests frequently conflict with those of farmers when it comes to regulation. Along with farmers, middlemen (super-markets, restaurants, and the like) may desire output restrictions to raise retail prices, but they will not want high wholesale prices." There are industry-specific and broad agricultural campaigns underway to try and shift this balance of power (see, e.g., Dairy Together or Disparity to Parity), but they face an uphill battle.

Conclusions: Implications for the broader environmental community

For environmental communities who might seek to enact change in livestock—and especially dairy—industries, this research offers some bigger picture lessons. First is to reinforce the reality of complexity. Research that identifies a single lynchpin to catalyze changes in farmer decision making, supply chain dynamics, or consumer buying power can be enticing, and even reinforced by farmers or industry participants themselves. Researchers competing for scarce funding dollars and research positions are also incentivized to present their research in this way to garner buzz. But silver bullet solutions are illusions (Bell, 2010; National Sustainable Agriculture Coalition, 2021), and many of our problems in agriculture today stem from prior silver bullet solutions. As illustrated in this case, there are a range of influences driving industry directions. Perhaps a productive angle to work from is this more complex understanding, to seek to enact change in the industry that exists, not the simplified version that we might want to exist.

As an application in the realm of policy preferences: many producers express opposition to supply management and regulations broadly, in line with an expressed adherence to efficiency which they often say is inhibited by government bureaucracy (Field Notes). As many reject supply management and other regulations in the name of efficiency, at the same time efficiency requires stability, so the industry has embraced a sometimes high degree of government regulation (particularly in pricing) to try and buffer the volatile prices of a highly perishable product. Thus regulations have been embraced in the name of efficiency, the very value that is used to reject regulations. This is precisely the double movement presented by Polanyi in describing the twin goals of marketization and protection against marketization (Graddy-Lovelace & Diamond, 2017; Polanyi, 1944; Winders, 2009). The history of agricultural commodity pricing is complicated and the specific pricing hearing testimonies drawn upon here reflect mixed feelings about regulations, but industry actors seem to overall appreciate the relative stability that price regulation has brought. Even recently, when the industry rejected the long-standing state milk marketing order in favor of the federal order, there was a clear willingness to work under pricing controls. These seeming contradictions present an opportunity to embrace the nature of reality as messy, to acknowledge the complex and sometimes contradictory identities being held and acted upon in any circumstance, but here exhibited by farmers. If there is to be movement forward towards sustainability—economic and environmental—there is a need to challenge the idea that farmer decision-making and industry direction in general is beholden to a coherent rule or identity. We would benefit from seeing it instead as a mess of circumstances, wavering positions, and ‘muddling through’ (Lindblom, 1959; Scott, 1998). The history of the California dairy landscape, as a result of multiple streams of influences converging in distinct ways across the state, attests to this.

Second, this research reinforces that public policy is both difficult to write and has lasting impacts, making it doubly dangerous. Frequently in environmental presentations, conclusions will include a vague appeal to policy to correct the identified problem. This is understandable, and at least it acknowledges the important role of policy. But public policy is complicated and difficult to get 'right', and as illustrated here, it also has lasting effects in areas the drafters may not have anticipated. The California state milk marketing order’s initial goals to ensure an adequate supply of milk and cover production costs were laudable goals made at a time of concern over shortages; yet the shortages rarely materialized and instead the policies combined with other factors to create self-reinforcing mechanisms that incentivized surplus. The decision to have producer referendums on marketing order changes, combined with cooperatives’ ability to block vote for members, turns out to allocate power in ways probably not envisioned by those who decided on the policies. We in environmental disciplines in particular would do well to realize this reality in the frequent appeals to policy to fix our problems, and perhaps throw our support behind the (seemingly drawn-out) work to try and get it right.

There is real potential to use experimental or incremental policy approaches to implement supply management efforts while allowing for adaptation as problems and new information come to light (Hagen & Rose, 1989; Knaggård, 2014; Lindblom, 1959). Past history with U.S. supply management illustrates important potential for adaptive policy, as with the production controls that induced increased capital intensification of agriculture in the 1950s and 60s. This supply management effort included policy features meant to control the capitalization which continually made acreage limitations redundant, but they were always one or more steps behind the increase in per-acre yields (Cochrane, 1979, p. 385). Building in more adaptive capacity in the legislation might have created room to address this capitalization incentive in a more timely manner. Experimental or incremental policies might also double as strategies to address some cultural hurdles with producers, since many producers will scoff at the idea of government having such prominent say in their production decisions (Weingarten, 2018). An incremental process that allows for input and adjustment along the way could be an opportunity to achieve some level of buy-in from skeptical producers; incremental agricultural policy has in the past been shown to facilitate such paradigm shifts (Daugbjerg, 2003)

In his 2009 book on past supply management in the U.S., Bill Winders made the statement, “The solution to a problem is generally determined by how the problem is defined” (Winders, 2009, p. 39). The statement is worth revisiting given this look at California dairy history, in which the concept of oversupply or surplus was both defined numerous ways and also denied existence as a problem at all. Indeed, since surplus has regularly come as a result of producers becoming more efficient with (a limited set of) their resources, surplus itself has rarely been framed as the problem (Clunies-Ross & Hildyard, 1992). Attempts to reign in surplus and institute efforts like supply management will have to contend with this more basic problem if they are to be successful. They will have to find a way of moving past the abiding willingness to see surplus as a blessing of efficiency, rather than a problem in and of itself.

Chapter 4. 'What happens in California moves east': Understanding agriculture's engagement with environmental policy in an agenda-setting state

Introduction

Environmental policy is used to control negative environmental impacts as well as to incentivize positive or more sustainable environmental practices. Command-control regulations mandate performance outcomes or specific management behaviors, while incentives-based policies aim to entice actors to take up desirable practices (Moran et al., 2008). In California, agricultural producers have long dealt with command-control policies from the Air or Water Resource Boards. Also in California, newer policies like the *Short-Lived Climate Pollutant Strategy and associated State Bill 1383* target methane production from dairies and utilize incentives like grant programs to integrate climate-friendly dairy production practices. This approach is an example of the new governance strategy, which incorporates economic incentives and emphasizes public-private alliances (Fiorino, 2006; Salamon, 2002; Salamon & Elliott, 2002).

Understanding how producers respond to environmental policies—those that regulate negative impacts as well as those that incentivize more sustainable actions—is important for understanding policy's efficacy and potential to shape or transform sectors like agriculture. Particularly so in California, which is widely recognized to set the agenda for environmental efforts nationwide (Klyza & Sousa, 2013; Linnekin, 2009), agricultural and otherwise. Responses to environmental policies are shaped not just by the policies themselves, but also by the actors and institutions associated with them. In California agriculture, environmental policies fit into histories of interaction between producers and various environmental groups and regulatory bodies, where relationships have often been strained (Niman, 2014; Pincetl, 2003). If California is to set the agenda for the nation, we must understand how producers conceive of and interact with the policies we have implemented and the rhetoric we have employed. How do producers conceive of current environmental policies, and what does this tell us about policies which can be successful? How might it shape future efforts in California and nationally?

This research uses ethnographic data to explore how some of California's dairy producers interpret and participate in new initiatives to address climate impacts of dairy and create more sustainable production landscapes. To do so I draw on sustainability transitions theory, which seeks to understand how sectors shift to more sustainable models. While applied most heavily to energy development, the transitions literature has valuable insights for agriculture, as well (Avelino & Wittmayer, 2016; Bui et al., 2013; Lamine, 2015; Marsden, 2013; Rossi et al., 2019; A. Smith, 2006). I also draw from research into rural-urban dynamics, because livestock production is an inherently rural—or at least, exurban—form of agricultural production, one which urban populations have regularly sought to exclude as cities expanded (for California examples see Campbell, 2005; Gilbert & Wehr, 2003; Von Kampen, 1977). Thus existing rural-urban tensions are enflamed when groups associated with more urban spaces (state or national governments and environmental movement actors) seek to change a rural-identified livelihood in the name of sustainability. If it is true that "As California goes, so goes the nation" (Klyza & Sousa, 2013), then it is crucial to understand how California's latest environmental policies have been received and enacted by some of the targeted producers.

Theoretical Concepts

Sustainability transitions theory provides valuable perspective into the ways that California dairy can transition to more sustainable forms. The literature includes an interpretation called the multi-level perspective (Elzen et al., 2004; Geels & Schot, 2007), which is particularly useful for agricultural sustainability questions as it pinpoints the importance of scale in sustainability transitions. The multi-level perspective posits that small, localized beds of experimentation into sustainable practices—dubbed technological niches—allow for innovation which can then scale up and/or out to reform the broader socio-technical regimes. Socio-technical regimes are the broader sets of norms and institutions which influence our everyday actions, keeping certain practices or behaviors prevalent and inhibiting others (Elzen et al., 2004; Geels & Schot, 2007; Lawhon & Murphy, 2012). Thus sustainability transitions literature identifies the need for diverse actors and approaches across many local technological niches, so that experimentation can identify strategies that work in local and regional contexts (Rossi et al., 2019; A. Smith, 2006). Supporting niche development requires understanding local actors and institutions at play and building new initiatives that include them, rather than planting alternative food systems and assuming everyone can or will join in (Lamine, 2015). The state and its environmental policies can be an important part of niche development (Johnstone & Newell, 2018; Rogge & Reichardt, 2016), though it is important to keep in mind that states are want to keep transitions technical and legible rather than adaptive and determined collectively (Scott, 1998).

Avelino and Wittmayer (2016) identify the need for those involved in sustainability transitions—and in the case of agriculture, producers are key actors (National Sustainable Agriculture Coalition, 2020)—to feel a sense of agency and influence if they are to contribute meaningfully. This insight also appears in research on natural resources co-management practices (Natcher et al., 2005). Valuing the contributions of diverse actors can mean messier negotiation about goals and strategies, but it constitutes an important part of the work towards more sustainable food systems (Hassanein, 2003). This is a key point where rural-urban dynamics connect to sustainability transitions theory. The rural-urban tensions that exist broadly between rural communities and urban environmental interests (Cramer, 2016; Walker, 2003) are prone to arise when sustainability movements from government or environmental movements—both generally associated with urban areas—seek to transform rural agricultural interests. This tense relationship is especially strong in regards to livestock production, where producers often feel the need to defend against environmental and animal rights critiques from urban residents or organizations (see, e.g., Niman, 2014). There is common recognition of the role urban-rural dynamics play in agriculture (Block & DuPuis, 2001; Cronon, 2009; von Thünen, 1826), and the importance of agriculture—livestock in particular—as a resource to address future environmental sustainability challenges (Smith et al., 2008; Sumner, 2014). If sustainability transitions rely upon producers feeling heard and involved, then rural-urban tensions need to be taken into consideration.

Methods

Data Collection

Participant observation and document review provided contextual data for this chapter, but interviews supplied the key information used to identify and explore perspectives of those in and associated with California dairy. Triangulation of data from documents, participant observations, and interview transcripts helped reveal multiple facets of the people and circumstances under study, creating a more complex, and thus more revealing, depiction of the social context (Fossey et al., 2002; Lincoln & Guba, 1985; Silverman, 2015).

I reviewed recent reports and press releases from California dairy industry organizations (e.g., Western United Dairymen), literature from other agricultural organizations in the region (e.g., CalCAN), local news stories, government reports (e.g., California Department of Food and Agriculture, 2008), and academic research to create a better picture of the current context for dairy production in California. I attended industry organization meetings and professional conferences, volunteered with dairy-affiliated groups, and attended community events to meet and learn from dairy producers and those in dairy producing communities. From this participatory work, I conducted 35 informal interviews with key informants to establish an understanding of the concerns, challenges, and needs of industry participants and to structure my interview guide. From these informal interviews I went on to conduct formal, semi-structured interviews with 33 dairy producers, vendors, state agency employees, and regulators; 10 semi-structured interviews followed up with those who engaged in informal interviews and 23 were new contacts (often at the suggestion of those who participated in initial, informal interviews). Thus a total of 58 participants participated in informal or formal interviews. I conducted the semi-structured interviews using an interview guide, but allowed informants to guide and direct the flow of conversation. In this way, the informant's view of the situation could emerge throughout the interview (McCracken, 1988). Interviews ranged in length from approximately 30 minutes to three hours.

An iterative analysis process helped continuously refine the data collection process (Glaser et al., 1968; Glaser & Strauss, 1967; Strauss & Corbin, 1997). This meant that initial stages of research—particularly informal interviews and field notes—helped to prompt additional avenues for research to explore and expand upon important themes. For example, initial data analysis of interviews identified a prominent theme among producers that needing to balance multiple environmental regulations was at times unbearable. This finding prompted targeted document review to identify the range of environmental regulations applicable to California dairy producers and the various actions required by these regulations, to better understand what the pressure of environmental regulations meant for producers.

Because trust was a key issue for accessing dairy producers—given the historical tension between livestock producers and the environmental discipline in which I work—I utilized snowball sampling to identify interviewees among California dairy producers and other industry actors. Each interviewee was asked to connect me with additional informants; I followed these connections until they started overlapping and data themes exhibited saturation within the dairy industry community.

Analysis

Data were analyzed drawing on methods from grounded theory, which allows themes to emerge from sources through continuous review and comparison of data (Draucker, Martsolf, Ross, & Rusk, 2007; Fossey et al., 2002; Lincoln & Guba 1985). I used NVivo 11 Plus software to open code transcribed interviews, field notes, and documents, and identified emergent themes among different sources and categories. I attached coding categories to portions of data, and compared the coding scheme to new data that was collected. The coding scheme was continually revisited throughout the research process, so that I could refine and develop categories as new data emerged. As patterns or themes emerged during data collection, I shared them with key informants who were able to confirm or reject thematic accuracy, elaborate on the themes, or suggest further avenues for research. This process allowed the resultant narrative to be grounded in the available data (Bernard, 2017). Presenting the preliminary themes to research participants helped improve the quality of the data (Hammersley & Atkinson, 2007; Lincoln & Guba, 1985) and ensure that the multiple meanings that different community members assigned to different events and ideas were represented (Lincoln et al., 2017).

I use a naturalistic approach to report results (Lincoln & Guba, 1985), meaning where possible ideas are presented in informants' own words. This reflects my purpose to understand and explore the meanings and processes associated with dairy production as told by informants. The naturalistic approach aims not to generalize over multiple meanings with numerical representations, but to recognize and explore the multiple realities that inevitably arise from social circumstances (Lincoln et al., 2017; Lincoln & Guba, 1985). An analysis built from numerous informant quotes allows multiple realities to be represented directly, as rich descriptions which together form a detailed picture of producers in their settings. This approach allows the reader to assess the coherency and consistency of the research and its conclusions (see, e.g., Cramer, 2016; Hochschild, 2016). Content gleaned from participant observation and informal interviews is cited as Field Notes, while content gleaned from semi-structured interviews is cited with the interviewee's randomized number. To protect informant confidentiality, identifying details from statements are either removed or changed.

Clarifications

A few caveats are necessary to understand the scope of the conclusions presented here. First, I expand the scope of analysis to consider not just responses to policy and regulation directly, but to actors and institutions lumped into the category of "environmental", because producers readily discussed them collectively. Second, while there are important variations in the types of environmental policies implemented for agriculture—such as the command-control and market-based incentives approaches mentioned earlier—dairy industry actors in this study discussed them under the same umbrella. Often—though not always—the term "regulations" was used to reference environmental policies broadly, whether the speaker was referencing measures from regulatory bodies or voluntary incentive programs. The range of environmental policies are therefore discussed collectively here, except where it is necessary to distinguish between types of policies for clarity. Lastly, the informants drawn on for this research do not constitute a representative sample for all of California dairy—participants in this research skew in support of the environmental policies discussed, as there is a clear selection bias for those more willing to talk to someone from an environmental community. Thus the discussion included here should be taken as a conservative estimate of the broader industry feeling, and representative of those more open to dialogue with environmental groups.

Environmental Policy and California Dairy

Sustainability transitions literature suggests that localized innovations are necessary to test out new, more sustainable practices which can then scale out depending on regional characteristics (Elzen et al., 2004; Geels & Schot, 2007). To the degree that they can support local technological niches and the involvement of local actors, environmental policies can play an important role in this process (Avelino & Wittmayer, 2016; Johnstone & Newell, 2018; Rogge & Reichardt, 2016). Below I explore the ways that environmental policies engage with sustainable transitions in California dairy. To what extent are local technological niches supported and encouraged by environmental policy implementation that affects and/or targets California dairy producers? Does policy encourage a diversity of innovations that recognizes local needs and actors and encourages their meaningful involvement?

Environmental policy implementation

Compliance requirements

Predictably there was no unifying perspective among research participants on something as controversial as environmental policies, but many identified frustration with policy requirements while also acknowledging some benefit from the efforts (Field Notes; Interview 28). Most often, frustration was targeted at broad references to flaws in policy implementation, or to the time and effort needed for compliance. A common explanation on the latter was given by one informant:

> Interviewee 31: … So there's, there's also you know over these 30 years there's been major increase in regulations.
>
> Rachel: Ok, yea.
>
> Interviewee 31: Now most of those have good intentions, they're trying to improve water quality, they're also trying to be sure that manure and methane are handled and managed correctly, but it's just, it's another production cost. It's another time commitment, it's, they're more hurdles that in other areas producers don't have to go through as stringent. And obviously we have a lot of important natural resources to protect here, so there's reasons behind them, but there's also a lot of politics and a lot of, you know, folks watching kind of what everyone's doing. So that's just another element besides the economic hurdles maybe that some folks have to, to deal with.

Despite their frustrations, informants often appreciated efforts by regulators or policymakers to try and make compliance easy, a recognition of the need to work with resource-limited producers. Otherwise, as one participant identified, if compliance was too difficult then individuals might just "do things in the night", meaning they would carry out projects without the required paperwork or oversight:

> Interviewee 13: And probably a lot of people do things that they should have permits for.
>
> Rachel: Mhm, I think so.
>
> Interviewee 13: Because it's too much red tape, Rachel, to do it! And I know that's not right, but that's the way it is.

Thus a critical point for some informants was state and local efforts to work with producers and industry actors to facilitate the required sustainability practices and innovations, such as through providing logistical or financial support. As one industry affiliate discussed the new State Bill 1383 to reduce methane emissions from dairies:

> The one thing that's interesting in that is that you know there is a statement in there about, they're not, California is not trying to drive the problem somewhere else. They don't consider it successful by just driving the dairy industry out of California and creating a problem in Idaho or New Mexico or wherever they move to, so they're, whether you know they can stick to that wording or not, but the wording's in there that we want to try and work with the dairymen and keep them here and resolve their problems here, not drive them out of the state. So I'd like to see that actually happen, but it's definitely going to be a big learning curve for them. (Interview 7)

The risk of operations leaving the state was frequently referenced, and a number of informants knew producers who had operations in other states in part because of different regulatory climates (Field Notes). California's grant programs were cited as a key means to support local producers in their sustainability efforts:

> Other states, these are not things. You could maybe go to the NRCS [Natural Resource Conservation Service] and get some EQIP [Environmental Quality Incentives Program] funds, that's it. The states are not investing in, in climate change solutions like California is, and I think that's absolutely incredible." (Interview 11)

Public funding was emphasized repeatedly as an important way to support producers who sought to meet regulatory requirements or make sustainability interventions, but who could not fund projects themselves because of persistent difficult financial circumstances for milk producers:

> Many of the producers, I feel like they're at the table, nobody wants the water board chasing after them. So they're at the table, they're engaged, they're wanting to meet the requirements, but when you financially cannot afford to do that, you're stuck. There's no give, there's no… you're stuck. So somebody else has to come in, whether it's that land trusts or the federal government or the RCD [Resource Conservation District], or programs like that Alternative Manure Management Program which really looks at large-scale operational transitions that are very expensive. (Interview 15)

Dairy industry actors described ongoing efforts to engage with policymakers about implementation of environmental policy. Industry organizations worked with state legislators, and the non-profit organization Dairy Cares was frequently identified as a key influence shaping regulatory requirements to reflect dairy producer and processor needs and circumstances. Locally, informants described committees which consisted of producers and regulators that met intermittently to discuss needs and challenges (Field Notes).

Yet this ongoing collaboration about environmental policy did not preclude discontent about policy implementation. While some lauded California for its efforts to make policy more user-friendly, others saw the state's environmental efforts as perpetually fraught. Some research participants sighed when I asked about environmental policies in California, and one interviewee cited high blood pressure as a reason he could not talk about it further. Informants frequently said it was not the goals themselves that were the problem, but rather the implementation (Interviews 3, 4, 11, 32). Perhaps most frequently cited was the sheer amount of resources producers put into demonstrating their compliance with environmental policies, which many said had increased drastically in recent years. "If you look at what I have to provide for the government today, versus [decades] ago, it's a night and day difference. I mean it's, wow" (Interview 16). The documentation was often cited as more intensive than the work to meet environmental requirements:

> Rachel: So, I think, with regulations there's the, the whatever act or measurement or whatever the regulation is targeting, but I think there's also this important piece of the time and resources that go into documenting compliance with the regulation.
>
> Interviewee 17: Oh, certainly.
>
> Rachel: So I'm curious which, do those weigh equally, is there one that feels more ominous than the other?
>
> Interviewee 17: Oh yea, the documenting seems more gruesome. Yea, certainly.

Producers cited the volume as well as the complexity of reporting requirements:

> They're always increasing regulations and increasing what you have to report annually, and then even within that increasing the length of the forms and everything. It's just always increasing. You know, I have to report to them, the EPA, the list goes on and on and on. It's ridiculous, and it's more and more every year and that's the tough part of it is you have to not only manage a dairy but you've got all these people just always with their prying eyes and their forms and their reporting and their monitoring and things like that that you have to, you have to appease, I guess. Report to them. It's, it's difficult, it's difficult. A lot of them make the forms very tricky to

> where it almost seems like they're trying to trick you, they'll ask you several different things in several different ways. (Interview 20)

Some producers said that they had the equivalent of a full-time employee working on regulatory compliance (Interview 5) while others paid outside consultants (Field Notes), but either approach was cited as difficult to sustain with milk prices so consistently low (Interview 11).

Policy in broader context

Outside of the specifics of environmental policy requirements, informants often cited difficulty juggling environmental policy demands amidst other competing concerns. Some informants even identified conflicting requirements between environmental policies (Interviews 3, 7). One interviewee suggested that in the past "…there, has been instances where regulation for one group has trumped regulation for another group. Within the states and the agencies. And so, what is a dairyman to do when that happens?" (Interview 29). Though with better communication among regulators these conflicts were said to be decreasing (Field Notes). Beyond conflicts among environmental goals or requirements specifically, the act of juggling multiple regulatory demands wore on producers:

> And in my time I've lived through, you know, every conceivable possible regulation having an impact on us from groundwater regulations to air regulations to groundwater supply regulations, wage regulations, you know, OSHA regulations, like every, climate change regulations that are coming, and everything that you touch on a farm is now being regulated in some form by the government. (Interview 14)

Informants said the challenge of juggling so many concerns had direct impacts on the survival of dairy farms. These stories were frequently brought up by people across the state in all aspects of dairy, and informants often showed distress over the loss of other dairies. One North Coast producer said the combination of economic and environmental pressures was crucial in slashing the number of dairies in his area by almost 75%:

> Interviewee 27: We've, 30 years ago we had 300 dairies here.

Rachel: Right.

Interviewee 27: Now we're lucky, we don't, we got about 80 or 90. We've lost ¾ of our dairies here. And they just, they couldn't, we're in an area where you can't, it just isn't feasible to have large 1,000-cow dairies come out to anything. And so the number game itself, we haven't been able to compete with the large dairies in the valley. And uh, pollution drove a lot of dairies out that, in the '70s and early '80s. It was just gonna be too expensive for them to be able to regulate their, all their manure flows and everything, and put ponds in and stuff. So they just folded up and went out of business.

Another producer again cited combined economic and environmental pressures as well as difficult working hours, but saw effects specifically on farm succession (meaning, finding a next generation to take over the operation):

Interviewee 10: … But I'm concerned about succession of the industry to continue to go on. It's hard to say, I mean I look around here, I was the young guy at one time and I'm the old guy now, and the majority of those going out of business there was nobody to take it over. There was nobody to take it over. They didn't want to be burdened with a locked down 24/7, you know, they didn't want to be locked with the environmental stuff and the laws that you have to deal with and the paperwork and all the other stuff that you have to deal with.

Rachel: It's just too much.

Interviewee 10: It's just too much. I can go out and get a job and I don't have to worry about it, and I can go home and go to the football game and whatever I want to do in my time off and whatever I want to do if I make enough, and they said "The heck with it."

The loss of dairies was described as particularly pronounced for operations with certain characteristics: those smaller in size with fewer resources, those with older producers who are less tech-savvy, or where operators may have limited English literacy skills. One producer described an incident after a workshop on air quality regulations:

Interviewee 12: So when we came out of that ridiculous workshop, there was an old guy, he must have been like, I don't know, 70 or so.

Rachel: Ok.

Interviewee 12: And he didn't speak real good English and he wasn't a reader or writer that much. But he was a good dairyman and he worked hard his whole life.

Rachel: Ok.

> Interviewee 12: He came out of that meeting and cried. He says, “I don’t have the ability to comply with these regulations.”
>
> Rachel: Right.
>
> Interviewee 12: And it takes a young kid to be able to understand a computer and know how to report all this stuff and to report it in the right order and the right fashion that they want. It’s all about paperwork. Every single piece of equipment that uses gas has to have a log book, you have to write down what day you used it, what time you used it, how long you used it for.
>
> Rachel: Wow.
>
> Interviewee 12: And you’ve got to log in and out of that book for every piece of equipment you own.
>
> Rachel: Wow.
>
> Interviewee 12: And that guy just said, he’ll have to go out of business ‘cause he just can’t. He can’t do the paperwork that they’re now asking him, that’s required to do.
>
> Rachel: Right. And is that a, is that a kind of scenario that you’ve seen play out with other producers, too?
>
> Interviewee 12: Yea, so that’s what I’m saying. It’s just, it’s getting harder and harder for a farmer, a small farmer, to stay in business.

The combination of pressures painted a bleak picture for dairy producers in California. As one industry affiliate summed it up: “The feeling is pressure-cooker, i.e., how much more can you squeeze us? A lot of them are barely hanging on and only doing so because they have land. Those that have debts, their debts are just getting larger” (Field Notes).

Thus the environmental policy situation for California dairy producers resulted in two distinct but related views. The state’s environmental policy agenda was seen as ambitious, but informants identified that the state and industry provided some support to help producers contribute to a more sustainable industry future. To support regulatory compliance a number of producers utilized the California Dairy Quality Assurance Program, part of which helps producers understand and comply with applicable regulations; the program is supported by the California Dairy Research Foundation, which is funded largely through checkoff dollars from local dairy producers. Many producers applied to or were interested in new state incentives to change their manure management practices away from anaerobic conditions (Alternative Manure Management Program) or to install anaerobic digesters which collected methane for use as biogas (Dairy Digester Research and Development Program). While these forms of support were present, the specifics of policy implementation demanded substantial resources from producers, and these combined with other (particularly economic) stressors were seen as contributing to the loss of numerous dairy operations, especially those smaller in size (Interviews 3, 7, 16). Clearly there was intent for the state's environmental policies to support and encourage local environmental improvements and sustainability innovation, but the resources required to comply with regulations and participate in environmental policy incentives have limited the impact of these efforts.

Producers clearly identified that the multiple pressures they had to juggle made it challenging for them to engage in environmental initiatives. At the same time, this difficult environment necessitates their involvement all the more. Due to the high cost of land, the capital-intensive nature of dairy infrastructure, and the permitting necessary to operate a dairy in California, no new dairies have been constructed in recent years (Field Notes) and almost 100% of informants told me that the only way to break into dairy in California was to inherit an operation. While sustainable agriculture discussions often look to new and beginning farmers as sources for new practices or ideologies, the financial and associated regulatory hurdles of California dairy make it unlikely for new farmers to come in to the industry outside of new generations of a family farm. Thus, at least in the near term, sustainability efforts must focus on reforming existing dairies.

Meaningful involvement

In the previous section, participants identified mixed feelings about the design and implementation of environmental policy initiatives. Beyond this perspective, to what degree do actors feel they have influence in and can contribute meaningfully to environmental efforts? To address this question, it is perhaps first worth asking: do producers want to build a more sustainable industry?

Stewardship goals

Research participants regularly discussed an ethic of environmental stewardship among dairy producers, one which came out of multiple facets of dairy livelihoods. First, they described a collective identity as environmental stewards, even as the "first environmentalists" (Interview 29). One participant identified how the development of farmer knowledge-sharing groups helped to expand a collective stewardship identity:

> But I also think the dairymen realized in order to be resilient we have to be a united front, also. So I feel like it's been a larger social movement of producers coming together for resiliency and conversation. But it's happening, and it's very much around 'what are you doing, why are you doing it?' It's better, it's just better received when you can talk to your neighbor or that guy down the street, somebody that's in your own fish pond if you will, than somebody coming in and 'oh you need to do this oh you should try this'. The information is just better received. I feel like our dairymen really are very aware of environmental regulation they're very aware of the players, they want to be in conversation, they want to be at the table. (Interview 15)

Even the pressure from environmental policy was—to a degree—identified as supportive of their stewardship goals: "Producers want to do better, so at some level it's good to be pushed on the environmental side" (Field Notes). Producers suggested that the struggles associated with policy compliance had made them stronger (Interview 10), admitting, "Everything that they made us do over the years, has enhanced us" (Interview 9). Producers repeatedly identified that while they had conflicts with legislators, regulators, and the specifics of environmental policies, they saw a shared goal of sustainability in the end (Interviews 4, 5, 17).

Many said that this sense of stewardship came in part because of dairy's family orientation. Most dairies have been handed down to successive generations and this was a key emphasis for stewardship perspectives:

> Well, I think it gets lost in the shuffle of business sometimes but, as farmers we're not trying to deplete our water sources or destroy the ground or harm the environment. You know, this is, we continue as a farming operation if we're sustainable. You know we didn't last six generations here by destroying the earth. (Interview 5)

They pointed to their children as explanation for why they took up sustainable practices (Interview 28), and as the reason they were focused on environmental quality: "My family's drinking this water, I want to make sure it's safe" (Interview 3).

At the same time, a number of informants identified that environmental stewardship was financially beneficial, and that ecologically-oriented management reduced input costs (Interview 1). One producer described a synergy between environmental practices and financial profitability, which was realized after the operation took up certain conservation practices in anticipation of regulations:

> I discovered that there's a lot of actually agronomic opportunities in doing [specific practice], and that [specific practice] actually can be the most profitable way to farm. And so, I sort of went into a mode where everything I did, had to be the most profitable and environmentally beneficial way of doing it. (Interview 14)

There was a clear connection between stewardship and financial viability. Those who engaged in conservation or sustainable agriculture practices often identified an impetus to take up the practices for financial reasons, and not simply altruism. Producers frequently said that they did not make money if the animals and land were not healthy (Interviews 11, 16), and industry affiliates said that when milk prices rose higher, producers were more willing to undertake environmental initiatives (Interviews 7, 15). Most informants described a variation on the following statement, which saw some need for environmental policy but often disagreed with the approach being taken: "I don't disagree with the regulations that are being put on, I just disagree with how it's being done. There's issues in California but they are solvable, with our industries where they are" (Interview 11).

Us vs. them

In the previous section informants from California dairy described a desire to continuing improving sustainability of their industry, though they held varying views about how to go about the transformation. Since they describe basic agreement with the goals of sustainability initiatives, do they feel they can contribute meaningfully to the efforts underway? Are they able to have their voices heard and feel they have influence in the direction of environmental efforts? As they discussed their involvement with environmental initiatives, research participants described a high degree of frustration and relied most heavily on "us vs. them" language—often in terms of dairy vs. environmental or rural vs. urban groups—which indicates that the majority do not feel meaningfully involved in environmental initiatives.

As informants talked about those outside of dairy, they described an urban or environmental constituency that did not understand the reality of farming and/or seemed eager to discount animal agriculture. In regards to legislators:

> And what's tough as a farmer is that you have people in Sacramento or Washington who have never been to a farm or have no farming experience, coming up with algorithms as to how much methane you should produce. Or all of these different regulations and they don't really understand if that's gonna practically work or not. (Interview 5)

A flashpoint during the research timeframe was a lawsuit from environmental groups targeting ranches at the Point Reyes National Seashore, which informants drew on for evidence of environmental activists' ignorance about dairying (Field Notes); an example was the (unsubstantiated) suggestion by activists that park visitors could acquire Crohn's disease from cattle who might have Johne's disease (Interview 11). Producers also pointed to the consumer demand for food product certification schemes that required illogical or problematic practices, such as keeping horns on dairy cattle which is widely seen as unsafe for workers and animals[72] (Interview 12).

Producers and industry affiliates alike described a gap in understanding between producers and those outside of agriculture—perhaps related to the overall decrease in the farming population (Interview 28)—which they said led to conflict when producer environmental stewardship was ignored and they felt accused of being bad farmers (Field Notes). Producers could not see their sense of self—as environmental stewards, as hard workers—reflected in the environmental rhetoric around dairy production. Importantly, this led many informants to identify the need to focus on relationships moving forward:

> I think, what I see in dairy producers is their commitment to farming, they're not afraid to work, they're not afraid to take on a lot of debt, they're not afraid to do a lot of things. That's their way of life. There's love, I think there's huge assets that they have that they need to kind of know how to work better with the processors and the brands and the community to kind of really say, 'We're here to work with you, and kind of, you know, collaborate.' So I think it's relationships right now that need to be worked on, and the collaborative environment that really helps us move to the future. (Interview 4)

But collaboration requires trust, and an overarching theme was a lack of trust between those in dairy and those pushing for more environmental initiatives (Field Notes). One producer—whose statement was reflected in spirit in numerous interviews—said that as an organic farmer he valued environmental health but was continually frustrated by opaque communication from regulators:

> Interviewee 20: So I get, I get frustrated with that. Because I feel like we should kind of be on the same team, you know, an understanding of, like, ok I understand I have to do this reporting because there's a problem with the like—let me see the other side of it and let me see why you're asking these questions. So if we could just be on the same page.

[72] See, for example, Fentress Swanson (2015).

> Rachel: Does it seem like there's not a transparency about why things are happening?
>
> Interviewee 20: Yea.
>
> Rachel: Ok.
>
> Interviewee 20: They just, you know, tell us these new rules or things like that, whereas if we could see the other side of it then it would make more sense. And I think, I think that if there was more transparency then dairy farmers would be more open because I can see the reasoning behind it and feel like they're being, the agencies are being truthful and transparent, so it would go hand in hand.

As a researcher in an environmental department at a university known for its progressive politics, informants were often wary of me. Even after gaining enough trust to grant an interview, people often entreated me to be fair to their profession. One producer with whom I spoke multiple times added at the end of our interview:

> Rachel: I want to, if there's anything else you want to mention before we wrap up the call I want to give you an option to do that.
>
> Interviewee 25: Um, yea, I'm all twisted up between UC Santa Cruz and [location in Central Valley], California.
>
> Rachel: [laughter] It's not a usual combo.
>
> Interviewee 25: I don't, yea. I don't want you to fabricate anything.
>
> Rachel: Oh no!
>
> Interviewee 25: And I know I trust you wouldn't.

My conversations with industry participants demonstrated just how pervasive was the mistrust of environmental groups and actors. As another industry affiliate explained to me, "The attitude that most in the industry have is that environmental communities don't want animal agriculture at all" (Field Notes).

All of the above feeds into the perception by those in dairy that they are targeted by regulatory officials, activists, and the broader (generally urban) public. Research participants described onerous regulations targeted at dairies because they were low-hanging fruit (Interviews 12, 29); consumer trends and activists which aimed to put them out of business (Interviews 7, 9); and lawyers that fished for vulnerable (unpermitted) dairies as fodder for environmental lawsuits (Field Notes). Despite the tension most informants described, one offered a description of a way forward for dairy's relationship with environmental policy, likening the situation to being at a ball with different dance partners:

> [You] need to assess where each one is at and adjust your performance to make sure each person feels like they had a good experience. In policymaking, that means making each person feel like they've been heard, and that they are getting what they want—or at least a major part of what they want—out of the deal. (Field Notes)

The feeling of meaningful involvement this analogy describes is often missing for dairy industry actors engaged with environmental initiatives.

Discussion

Mosaic of sustainability initiatives

For dairy producers there was no single cohesive perspective on environmental initiatives, as is to be expected in an industry with a diversity of actors. Some producers described an intrinsic desire to meet environmental goals promoted by environmental communities (e.g., reduced tillage, carbon sequestration, etc.), while others did not necessarily espouse climate mitigation goals but saw financial gain or understood the necessity given regulatory climates. This identifies a range of capacities to take up sustainability practices, and underscores the need for varying sustainability interventions to improve upon the current state of things. Some producers may take up rotational grazing and go to 100% grassfed cattle and maximize their carbon sequestration potential because of an overall emphasis on sustainability. Others may install digesters because of the incentives to sell biogas commercially.

There is often resistance to the latter—anerobic digesters which create another marketable product—within environmental communities, because it utilizes market-oriented perspectives that are associated with the creation of environmental problems like climate change or nutrient pollution in the first place. This is worth digging in to further. Agricultural production in the U.S. trends toward large, consolidated operations (MacDonald et al., 2018), propelled by a technological treadmill that results in ever-increasing production and low food prices (Cochrane, 1979; Diamond, 2013). This market-oriented cycle has clear environmental impacts as more resources are used to produce food as cheaply as possible, resulting in environmental externalities (Sanderson & Hughes, 2018; Ward, 1993). If a reliance on markets created today's environmental problems it is logical to be wary of using markets to try and solve the same problems. Yet market-oriented strategies appeal to a range of producers exactly because they utilize familiar mechanisms, and for that reason they should not be discounted, at least in the near-term.

Producers may be drawn in to more sustainable practices by market incentives but then grow to identify with the overall mission, or they may take up ecological management because it makes good business sense; both of these trajectories were described by producers in this research, from both organic and conventional operations across the state (Interviews 1, 9, 14, 17). There is no clean separation between practices that are adopted for ecological reasons and others that are adopted for market-based incentives. Producers in this research and elsewhere have identified adopting pasture-based organic production—a practice generally associated with a more ecological mindset—because of market incentives. On the flip side, at least one prominent name in California organic dairy is trying to make digesters—a practice presently associated with market-based incentives—accessible to operations of all sizes with the goal of incentivizing closed-loop on-farm resource use (Straus Family Creamery, 2021). The research into conventionalization of organic production identifies important problems and limitations of market-based incentives towards more sustainable agroecosystem management (Guthman, 2004), but it does not mean market-based approaches are without utility. Importantly, environmental movements stand to gain followers by highlighting the economic efficiency of more ecological forms of agricultural management (e.g., Van Der Ploeg, 2000).

It is necessary to look at which specific environmental issues need to be addressed in local areas, and how this matches with possible gains from varying practices. More directly identified in this chapter, it is necessary to understand what capacities local institutions and actors bring to the table. Variation in producer capacity can align with the sustainability transitions literature, which identifies the need to have a variety of participants on a range of pathways to (greater) sustainability. Because regions of production are situated in their own geographic circumstances—ecological, political, and economic—they necessitate localized solutions. It is to be expected that some of these solutions will cause friction for others involved in sustainability efforts; as Hassanein (2003) identifies, conflict and negotiation over solutions is an important part of the process in food system movements.

There is important discussion about the difference between incremental change towards sustainability and moves that merely 'adjust the status quo' (see, e.g., Montenegro de Wit, 2021). Sustainability transitions theory offers some insight here, as the literature has struggled with the question of what sorts of technological niches can best transform the broader socio-technical regimes: radical niches hold transformative potential but might be too extreme to scale up/out, while niches too compatible with the current socio-technical regime can just be co-opted without enacting significant reform (Bui et al., 2013; Lamine, 2015; Rossi et al., 2019; A. Smith, 2006). Smith (2006, p. 455) suggests that the answer is to have both, that a dialectic relationship must exist to consistently allow "more radical experimentation to continue amongst more committed actors whilst, at the same time, allowing mainstream reforms..." Other researchers focused on rurality have also identified a need for dialogical relationships in order to build and support more sustainable agriculture (Bell, 2010; Hassanein, 1999, 2003), but this is not present between environmental and livestock communities.

If livestock production is an important climate mitigation resource, enough so that public policy efforts target their practices, then there exists a need to develop more dialogical relationships between environmental and livestock communities. This would help to better understand the realities and capacities of livestock producers, and facilitate farmer decisions that build more sustainable forms of livestock agriculture. Yet dialogue requires input from both sides, in conversation (Bell, 2010). The conversation about livestock production from the environmental lens instead resembles a monologue, with limited representation of livestock producers and the complex realities that shape their decisions (see, e.g., Ahmad et al., 2012; Arbuckle et al., 2013; Buys et al., 2012; Haden et al., 2012; Nelson et al., 2010). There is room for future research to build on the insights of Avelino and Wittmayer (2016), Bell (2010), and Hassanein (1999), as well as that of natural resources co-management research (e.g., Natcher et al., 2005), and integrate more dialogue as well as sociocultural understanding between environmental groups and livestock producers.

Building on strengths

The tense relationship between California producers and environmental communities illustrated here has implications for the use of different environmental policies. Within California specifically, there is clearly a history of difficult relations between agriculture and environmental communities broadly, and livestock and environmental communities specifically. This was perhaps most starkly identified in the repeated references—from producers across the state, both organic and conventional—to past environmental regulatory officials stating that they targeted dairies for regulatory action because they were some variation on low-hanging fruit. At this point it is not possible to nail down the exact details of when or in what form these statements were made, or by whom. What is clear is that there is a pervasive narrative of environmental regulations being wielded as a weapon against dairies for seemingly arbitrary reasons. This narrative about regulatory officials paralleled discussions about environmental activists who producers felt targeted them without understanding anything about their operations.

Clearly there is a strained relationship between dairy producers and many environmental entities—including government officials—which would require time and serious effort to undo. Fortunately, many producers identified more positive relationships with select private or non-regulatory environmental entities such as specific land trusts or non-profit organizations, the Natural Resource Conservation Service (NRCS) or Resource Conservation Districts (RCDs), or private companies. This bodes well for the new governance strategy of environmental policy that California has taken up, which relies on public-private relationships to implement environmental initiatives. If the select environmental organizations that producers trust can facilitate involvement in these new governance environmental initiatives, then there is hope for sustained producer involvement despite the history of conflict.

The perspectives represented in this research suggest a difficult road ahead for environmental efforts aimed at livestock production. At the same time, it should identify that there are actors capable of sitting with their discomfort with environmental communities and making sustainable change anyhow. This paper includes suggestions for how to move towards more productive relationships between environmental communities and dairy producers. It is important to emphasize that these conclusions make no pretense of being able to wave a magic wand and convert an entire industry to take on the view of environmental communities. Indeed, this sort of silver bullet solution should be avoided (National Sustainable Agriculture Coalition, 2021). The suggestions included here would help producers who are open to and capable of implementing more sustainable practices feel more encouraged and supported in doing so, rather than cornered and under-resourced, as they currently describe themselves.

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Chapter 2

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Chapter 4

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