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The animal agriculture industry, US universities, and the obstruction of climate understanding and policy

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Abstract
The 2006 United Nations report "Livestock's Long Shadow" provided the first global estimate of the livestock sector's contribution to anthropogenic climate change and warned of dire environmental consequences if business as usual continued. In the subsequent 17 years, numerous studies have attributed significant climate change impacts to livestock. In the USA, one of the largest consumers and producers of meat and dairy products, livestock greenhouse gas emissions remain effectively unregulated. What might explain this? Similar to fossil fuel companies, US animal agriculture companies responded to evidence that their products cause climate change by minimizing their role in the climate crisis and shaping policymaking in their favor. Here, we show that the industry has done so with the help of university experts. The beef industry awarded funding to Dr. Frank Mitloehner from the University of California, Davis, to assess "Livestock's Long Shadow," and his work was used to claim that cows should not be blamed for climate change. The animal agriculture industry is now involved in multiple multi-million-dollar efforts with universities to obstruct unfavorable policies as well as influence climate change policy and discourse. Here, we traced how these efforts have downplayed the livestock sector's contributions to the climate crisis, minimized the need for emission regulations and other policies aimed at internalizing the costs of the industry's emissions, and promoted industry-led climate "solutions" that maintain production. We studied this phenomenon by examining the origins, funding sources, activities, and political significance of two prominent academic centers, the CLEAR Center at UC Davis, established in 2018, and AgNext at Colorado State University, established in 2020, as well as the influence and industry ties of the programs' directors, Dr. Mitloehner and Dr. Kimberly Stackhouse-Lawson. We developed 20 questions to evaluate the nature, extent, and societal impacts of the relationship between individual researchers and industry groups. Using publicly available evidence, we documented how the ties between these professors, centers, and the animal agriculture industry have helped maintain the livestock industry's social license to operate not only by generating industry-supported research, but also by supporting public relations and policy advocacy.

Keywords Animal agriculture · Climate change · Conflicts of interest · Methane · Meat and dairy · Policy obstruction · Universities · University donations

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1 Introduction

In November 2006, the United Nations (UN) Food and Agriculture Organization (FAO) published "Livestock's Long Shadow," a 390-page report about animal agriculture's environmental impacts. The report provided the first global assessment of animal agriculture's contributions to climate change and attributed 7.1 gigatons of CO2-equivalent per year, or 18% of global greenhouse gas emissions, to animal agriculture (the majority of which derived from beef and dairy production; Steinfeld et al. 2006). It is worth noting how novel this contribution was. None of the Intergovernmental Panel on Climate Change (IPCC) synthesis reports since 1990 had singled out animal agriculture as a sector. The report also made the case that the "livestock sector has such deep and wide-ranging environmental impacts that it should rank as one of the leading focuses for environmental policies" (Steinfeld et al. 2006).

Over the subsequent nearly two decades, the livestock sector did not become a leading focus of environmental or climate policy, despite additional attribution research that drew attention to food system emissions in general and animal agriculture in particular. Even if fossil fuel emissions were immediately eliminated, emissions from the food system emissions are on track to make it impossible to meet the Paris Climate Agreement's goals (Clark et al. 2020). Animal-based foods, including livestock feed, account for 57% of global food production emissions (Xu et al. 2021). Animal agriculture is estimated to be responsible for more than one-third of all human-caused methane emissions and more than half of all human-caused nitrous oxide emissions (Shindell et al. 2021; Gerber et al. 2013). Scientists have continued to emphasize that reducing livestock emissions must be considered in mainstream mitigation policy (e.g., Reisinger et al. 2021) and highlighted the benefits of mitigating methane emissions with a shift of production and consumption away from meat products (Clark et al. 2020; Ocko et al. 2021; Reisinger et al. 2021; Shindell et al. 2021).

The USA is the headquarters to some of the largest meat and dairy companies globally (e.g., Tyson Foods, Cargill; Institute for Agriculture and Trade Policy and GRAIN 2018; Lazarus et al. 2021) and is among the leading consumers of meat per capita (OECD 2023). Livestock greenhouse gas emissions in the USA remain effectively unregulated (Lehner and Rosenberg 2017) and government programs continue to support the expansion of meat and dairy production and consumption (Hayes 2022). US meat and dairy companies have, like oil and gas producers, lobbied against climate policies and also supported organizations identified as part of the "climate change countermovement," such as the American Farm Bureau Federation (Brulle 2014), to delay consensus and policy action on climate change (Lazarus et al. 2021).

Research into the climate change countermovement has mainly focused on "for-profit corporations and their allied trade associations, conservative think tanks, advocacy/front groups, and foundations" (Brulle 2014). However, university researchers and industry-funded university centers have also been identified as playing an important role in spreading climate disinformation and obstructing climate policy (Oreskes and Conway 2010; UCS 2007; Brulle 2014). A growing body of literature has underscored the importance of university experts in supporting industry efforts to shape scientific research and understanding on issues that span far beyond climate change (e.g., Brandt 2012; Proctor 2004, 2011; Bero 2019; Gillam 2017; Glenna and Bruce 2021; Almond et al. 2022; Washburn 2010; Jacquet 2022).

Industry funding is attractive to universities because of its scale, ease of acquisition, and the promise that research and other activities are likely to immediately impact society, but it can introduce a unique bias. Unlike other institutional funders (i.e., governments, philanthropic organizations), activities of corporations, including funding to universities,

frequently align with the corporations' own financial interests (Bakan 2003). Proctor (2011), a historian of science focused on how the tobacco industry influenced scientific research, noted: "A grant from Reynolds or Philip Morris is not like a grant from, say, the Ford Foundation. An application submitted to the Ford Foundation is not run by the legal department of the Ford Motor Company— which is more like what happens in the tobacco context. Tobacco grants are approved by damage-control experts at the companies, which means that tobacco money is more like development research— or a kind of advertising."

While all researchers have interests—including their personal values, motivations, and aspirations—financial interests can be uniquely problematic (Bero and Grundy 2016). There is a growing recognition that industry-sponsored research has led to measurable systematic biases across all stages of research, including study design, analyses, and results (e.g., Chopra 2003; Bes-Rastrollo et al. 2013; Oreskes et al. 2015; Nestle 2016; Lundh et al. 2017; Adekunle et al. 2020; Almond et al. 2022). Bero and Grundy (2016) note that "even when the methods meet high standards for internal validity, financial conflicts of interest may influence research results through other mechanisms, such as the framing of the question, how the study is actually conducted, and whether it is fully and accurately reported."

In addition, industry influence can extend far beyond the parameters of a single piece of research. Industries have hired university researchers to serve as expert witnesses in legal proceedings (e.g., Proctor 2004), to help establish regulatory standards (e.g., Legg et al. 2021), to write content for social media sites (e.g., Gillam 2017), and to develop and maintain websites (e.g., Hocevar 2016). In addition, researcher conflicts of interest may never be publicly disclosed (e.g., Wei et al. 2019). There are many documented cases of industries attempting to conceal their involvement in scientific research and messaging (Lipton 2015; Hakim 2017; Stuckler et al. 2018; Glenna and Bruce 2021; Legg et al. 2021; Franta 2022). University researchers can be used in expert settings, but also in popular discourse to delegitimize scientific knowledge by challenging research that established a problem or causation, challenging the legitimacy of other researchers, and challenging policy responses (Jacquet 2022).

Due to the scope of its influence, there are ongoing debates about whether universities and university researchers should accept funding at all from particular industries that profit from practices and products that cause harm—a debate that rose to prominence with tobacco (Cohen 1996) and now includes fossil fuels (Kumar 2023). In a 1996 special report in *Science* exploring whether universities, research institutes, and individual researchers should accept tobacco funding, one researcher—in defending his own industry grants—was quoted saying that he wished other industries would be so generous and added, "Wouldn't it be marvelous if there were a Beef Council that supported research?" (Cohen 1996).

There is, in fact, beef industry support for research, including research on the topic of climate change. Yet, the relationship between the animal agriculture industry, universities, and the climate crisis has received little scholarly attention. Here we traced the US animal agriculture industry's response to "Livestock's Long Shadow"—the first high-profile international report linking the livestock sector to climate change. An important relationship formed when the industry-funded University of California (UC) Davis professor Frank Mitloehner responded to the report.

The industry's initial investment in Mitloehner was followed by millions of dollars from industry groups over the next 15 years to support Mitloehner's research and public outreach activities, promote him as a climate expert, and, in 2018, help him launch the UC Davis Clarity and Leadership for Environmental Awareness and Research (CLEAR) Center, with the aim of "bringing clarity to the relationship of animal agriculture, the environment and

our daily lives" (CLEAR Center 2020a). In 2019, Colorado State University (CSU) announced that it, too, would create an industry-sponsored collaborative to develop and promote sustainability strategies that enhance livestock industry profits (Giordano 2019). In 2020, CSU named the center AgNext and hired Mitloehner's former student, Dr. Kimberly Stackhouse-Lawson, then the chief sustainability officer of JBS USA (a subsidiary of JBS S.A., the largest meat company in the world), as a professor of animal science and as the program's director. Today, CLEAR and AgNext are among the most prominent US university centers engaged in shaping public understanding and public policy related to the livestock industry's climate impacts. Here we explore the origins, activities, and social impacts of these two researchers and university centers as case studies to understand the relationship between the animal agriculture industry, US universities, and the obstruction of climate understanding and policy.

2 Methods

Social scientists and historians have used different approaches to understand the various tactics that industries use to influence science and policy, such as text analysis (Wetts 2020; Bertrand et al. 2021; Almond et al. 2022), qualitative description and interpretive methods (Proctor 2011; Brulle 2014); the creation of evidence-based typologies using inductive methods that infer a general rule from the study of particular cases (White and Bero 2010; Reed et al. 2021; Legg et al. 2021; Jacquet 2022); and deductive methods that look at how generic principles apply across specific industries (e.g., Gaber et al. 2023 evaluated chemical manufacturers according to strategies identified by White and Bero 2010).

We first traced the US animal agriculture industry's reaction to the 2006 report "Livestock's Long Shadow" including their funding to Mitloehner that led to a rebuttal of the report, and subsequent industry-related activities, including the eventual establishment of two university centers, and the hiring of Stackhouse-Lawson by CSU. We reviewed publicly available materials, including press releases, university websites (including using the Wayback Machine to look at earlier versions of sites), publications, CVs, social media accounts, media reports (using Google and Proquest), newsletters, Clarivate Analytics Web of Science, nonprofit Form 990 s, and materials retrieved through public records requests (note that private universities cannot be accessed via public records requests and each state has its own rules around access).

We also used inductive methods based on a wide range of sources from different industries—including tobacco, pharmaceuticals, chemicals, fossil fuels, and food—and their influence on experts to create a set of 20 yes-or-no questions for systematically analyzing the relationship between university experts and industry groups (see Table 1, which includes justification for each question with sources). Some of the ways in which university experts have engaged with industry were not included because publicly available evidence is rarely available, such as whether the researcher signed confidentiality agreements with industry (e.g., Hakim 2017), whether researchers agreed to only identify the funders with their permission (e.g., Song 2015), and whether some amount of funding is contingent on agreeable results (e.g., Michaels 2019). Some questions were also excluded because scoring would be too subjective, such as the researcher's willingness to provide commentary outside of their expertise.

We then deduced the answers to the 20 questions for Mitloehner and Stackhouse-Lawson (Table 1). Questions were scored 1 for "yes" (publicly available evidence present) and

Table 1 20 questions on the relationship between industry groups and individual researchers

#	Question	Justification for question	FM	KSL
Industry funding				
1	Is there evidence the individual has received research funding (i.e., grants) from industry groups?	Decades of research into industry funding, including from tobacco, pharmaceuticals, food, and chemicals, have found that it can influence the design, results, and publication of research in favor of the industry's products and/or interests (e.g., Chopra 2003; Bes-Rastrollo et al. 2013; Oreskes et al. 2015; Bero and Grundy 2016; Nestle 2016; Nestle 2018; Lundh et al. 2017; Adekunle et al. 2020)	1	1
2	Is there evidence that the individual has led a university center, program, alliance, or institute that has received funding from industry groups?	Industry funding can influence the policy positions of faculty-led academic centers (e.g., Almond et al. 2022)	1	1
3	Is there evidence that the individual has been employed (i.e., full-time employee, consultant, director, advisor, etc.) by an industry group?	University faculty can provide paid consulting or services to the private sector related to their expertise (Wei et al. 2019; Conley et al. 2019). Consulting can be both lucrative and controversial since it may influence the consultants' research and/or restrict academic freedom (Mello et al. 2018)	1	1
4	Is there evidence that the individual has received industry-funded awards, honors, or prizes and/or received industry-funded travel subsidies, payments for delivering talks, or other gifts?	Industry gifts and payments can influence researcher behavior (e.g., Wazana 2000)	1	1
Transparency				
5	Is there evidence that the individual has failed to disclose industry funding in instances when it would be the norm or required to do so?	Industries have often attempted to conceal their involvement in scientific research and messaging (Stuckler et al. 2018; Legg et al. 2021; Franta 2022)	1	1
Political influence				
6	Is there evidence that the individual has served as a member of a governmental or intergovernmental entity tasked with establishing or recommending methods, metrics, targets, research priorities, research funding allocation, or policies in which their industry funders have financial interests?	Industries have a well-documented goal "to implement industry-friendly standards of evidence in regulatory decision-making" (Legg et al. 2021)	1	0
7	Is there evidence that the individual has testified at a US governmental hearing on subject matter involving their industry funders' interests?	Individual researchers can influence policy outcomes through legislative testimony (e.g., Perna et al. 2018; Moreland-Russell et al. 2015)	1	1

Table 1 (continued)

#	Question	Justification for question	FM	KSL
8	Is there evidence that the individual has interacted with or presented to government regulators and/or policymakers at an industry-sponsored conference, lobby day, or other event?	Having researchers present at industry conferences and lobbying events is a well-established strategy for improving their perceived scientific authority and credibility (Fabbri et al. 2018)	1	1
9	Is there evidence that the individual has served as a testifying or consulting expert in support of industry interests in a legal proceeding?	Individuals who act as a testifying witness or consulting expert in legal proceedings can be "used to paint a sympathetic picture of the industry's conduct" (Proctor 2004)	1	0
10	Is there evidence that the individual has submitted a public comment, or the individual's work has been referenced in any public comments submitted by industry groups, to regulatory agencies in support of industry interests?	Industry funding can influence the likelihood that researchers will comment on regulatory rules, as well as that those comments align with industry interests (Bertrand et al. 2021)	1	1
Research influence				
11	Is there evidence that the individual has co-authored with industry employees and/or allowed industry group funders the opportunity to review research prior to publication?	Stuckler et al. (2018) delineate between "hard power" when the industry influences research design, analysis, framing, or results of the research, and "soft power," whereby the researchers seek to ensure the funders were satisfied and sought advice on study design and public presentation of research results	1	1
12	Is there evidence that the individual has repeatedly published in industry-funded journals or journals with editorial boards, including industry employees?	Research articles published in journals or symposia sponsored by corporations are more likely to be biased in their content (Bero et al. 1992, 1994)	1	1
13	Is there evidence that the individual has allowed an industry-funded individual or firm to prepare analysis or publish content under their name?	Corporations have drafted articles (or portions of them) that were then published under the names of academics without attribution to the corporation (e.g., Lipton 2015; Hakim 2017; Glenna and Bruce 2021)	1	0
Popular media influence				
14	Is there evidence that industry groups have referenced the individual's work in advertisements, online content, press releases, website features, or social media posts?	Companies may use social media advertisements, advertorials, and press releases that feature researchers to influence popular opinion and bolster their reputations (Jacquet 2022)	1	1
15	Is there evidence that the individual has published traditional media (e.g., op-eds, essays, letters to the editor) in support of industry interests?	Companies may encourage and support individual researchers to publish in traditional media outlets (Jacquet 2022)	1	1

Table 1 (continued)

#	Question	Justification for question	FM	KSL
16	Is there evidence that the individual has published or participated in social media (e.g., X/Twitter, blogposts, YouTube, podcasts) in support of industry interests?	Industries have encouraged individual researchers to create websites and be active on social media platforms (Hocevar 2016; Gillam 2017)	1	1
Kinds of arguments				
17	Is there evidence that the individual has challenged the existence of or minimized the significance of an industry-related social problem (e.g., climate change)?	In some cases, industries have worked with researchers to challenge the existence of the problem altogether, as in the case of oil and gas companies and their support for climate change denial (Oreskes and Conway 2010; Jacquet 2022)	0	0
18	Is there evidence that the individual has challenged or minimized the industry's role in causing an industry-related social problem (e.g., climate change)?	Industries have frequently worked with researchers to challenge the causal link between their products and the social problem, as tobacco companies did to challenge their products' causal link to cancer (Oreskes and Conway 2010; Proctor 2011; Jacquet 2022)	1	1
19	Is there evidence that the individual has made ad hominem attacks against reporters, activists, scientists, or other public figures seen as at odds with industry?	Researchers may be rewarded for engaging in ad hominem attacks against their peers (Jacquet 2022). Ad hominem attacks on other researchers—such as questioning competence, conduct, and/or motive—can be as impactful on the public's attitude toward those researchers' scientific claims as attacks based on empirical evidence (Barnes et al. 2018)	1	0
20	Is there evidence that the individual has challenged the need for regulations or promoted policy proposals (e.g., requests for subsidies) in a way that is favorable to industry?	Industries have funded researchers to shape policy in line with their financial interests, as in the case of oil companies that hired economists who routinely inflated the costs of climate policy (Franta 2022; Jacquet 2022)	1	1
		Total:	19	15

In this table, "industry groups" refers to agribusinesses, agribusiness trade associations, and other agribusiness-funded organizations. "Industry interests" refers specifically to interests related to climate change. "FM" refers to Frank Mitloehner, and "KSL" refers to Kimberly Stackhouse-Lawson

0 for "no" (no publicly available evidence). A high score would indicate reason for concern, but it is not conclusive—the details and nuances that inform the binary score matter, which is why we take a descriptive as well as systematic approach. See ESM 1 for detailed answers to the 20 questions.

3 Results

3.1 The "public relations challenge" of Livestock's Long Shadow

The media coverage of "Livestock's Long Shadow" highlighted that it was the first global assessment of the livestock industry's impacts on environmental problems and emphasized that the livestock sector's contributions to climate change exceeded those of transportation, which the report did not assess, but used as a passing point of comparison in the executive summary and conclusion. PETA and other animal welfare advocates, including musician Paul McCartney, cited the FAO report when promoting vegetarianism (Chang and Schmelzer 2007; Sunday Mail 2007).

The US animal agriculture industry took notice. The USA is home to roughly 6% (95.9 million) of the estimated 1.5 billion cattle in the world (USDA 2023; UN FAO 2023a). In February 2007, the executive editor of *Beef Business Journal* described "Livestock's Long Shadow" as "red meat for the vegetarian activists and their friends in the animal rights movement" and as "UN cover for their pre-existing bias" (Cornett 2007a). In December 2007, he again referred to the report in an article claiming that the beef industry had a "public relations challenge" and was "in danger of becoming politically incorrect" (Cornett 2007b). He advised Beef Checkoff, a producer-funded marketing and research program designed to increase consumer demand for beef domestically and internationally, to address beef's public relations problem.

After a University of North Carolina professor cited "Livestock's Long Shadow" in a medical journal editorial about the health and environmental benefits of reducing meat consumption (Popkin 2009), the Center for Consumer Freedom (CCF)—an industry-funded nonprofit organization presented as a consumer interest group—responded with a press release that claimed the professor was "spreading environmental misinformation about meat" and stated that US meat production "contributes a laughably tiny amount of carbon emissions" (Newswire 2009). CCF (which changed its name to the Center for Organizational Research and Education in 2014) was founded by Richard Berman, owner of Berman & Company, a communications firm that creates front groups and whose clients have reportedly included energy, tobacco, and food companies (Kranish 2013; Lipton 2014; DeSmog n.d.). In August 2009, the American Meat Institute, the largest trade association representing the meat and poultry industries (which later merged with another trade association to form the North American Meat Institute or NAMI), published a fact sheet that claimed "the data show that GHG contributions of US animal agriculture are far less than some reports have suggested" (AMI 2009).

But press releases from front groups and factsheets from trade associations do not convey the same credibility as statements from university experts, particularly if the industry can conceal its role in funding and recruiting the scientists (Legg et al. 2021; Jacquet 2022). That year, the beef industry funded Mitloehner, a professor at UC Davis, which led to a rebuttal of the "Livestock's Long Shadow" report.

3.2 "The scientist who debunked Livestock's Long Shadow"

In 2009, the Beef Checkoff program (the same program Cornett 2007b urged to take action) provided $26,000 to Mitloehner, then a Cooperative Extension Specialist for Air Quality in the Department of Animal Science at UC Davis, to conduct an environmental assessment of the livestock sector (Wright 2009). Mitloehner had received his Ph.D. in 2000 in Animal Science from Texas Tech University, where his dissertation focused on methods for measuring cattle behavior and management practices for controlling heat stress and dust in feedlots (Mitlöhner 2000). UC Davis hired Mitloehner in 2002 (Mitloehner 2021a).

It is unclear why the Beef Checkoff program sought Mitloehner for the job of responding to "Livestock's Long Shadow" given his lack of climate expertise, but it is possible his involvement in the politics of livestock air pollution had caught their attention. In 2005, the San Joaquin Valley Air Pollution Control District—a major dairy region with heavy smog (Eilperin 2005)—had prepared new regulations on air pollution from industrial dairy facilities. District officials developed a method for estimating emissions of volatile organic chemicals from dairy cows based partially on Mitloehner's research (Bustillo 2005a). Mitloehner publicly objected to the use of his data by policymakers on the grounds that his cattle air pollution measurements were too imprecise to be used to establish regulations (Keith 2005; Bustillo 2005a). Dairy industry groups used Mitloehner's claim that the proposed methods were not adequately backed up by science to oppose the regulations (e.g., Bustillo 2005b).

In 2009, Mitloehner and two co-authors published "Clearing the Air: Livestock's Contributions to Climate Change" in *Advances in Agronomy* (Pitesky et al. 2009; Mitloehner is last and corresponding author). They did not dispute the empirical evidence presented in the FAO report. The "primary focus" of the article was "to examine the relative contributions of livestock to climate change at different geographical and production scales." The authors spent the bulk of the article on the point that the relative contribution of US livestock to US emissions is smaller than the relative contribution of all livestock to global emissions. Pitesky et al. (2009) also stated that the FAO's comparison of livestock emissions and transportation emissions was flawed because the former included full lifecycle emissions while the latter included only direct emissions. The Beef Checkoff funding was not acknowledged.

The link between livestock and climate change was downplayed in the UC Davis press release, titled "Don't Blame Cows for Climate Change," wherein Mitloehner described "Livestock's Long Shadow" as a "lopsided analysis" that "truly confused the issue." He also said, "we certainly can reduce our greenhouse-gas production, but not by consuming less meat and milk" and "producing less meat and milk will only mean more hunger in poor countries" (Wright 2009). Neither of these statements or supporting research appears in the published article by Pitesky et al. (2009). The UC Davis press release acknowledged the Beef Checkoff program's funding (Wright 2009).

In March 2010, Mitloehner gave a presentation on the topic at the American Chemical Society, which issued another press release, which did not acknowledge the Beef Checkoff's funding, titled "Eating less meat and dairy products won't have a major impact on global warming." In it, Mitloehner challenged the usefulness of campaigns for "meatless Mondays" and "Less Meat = Less Heat" in Europe and "said that giving cows and pigs a bum rap is not only scientifically inaccurate, but also distracts society from embracing effective solutions to global climate change" (ACS 2010).

The UN report's authors acknowledged Mitloehner's criticism of their comparison to the transportation industry. One author of the report said that Mitloehner had "a point" and that they had "factored in everything for meat emissions, and we didn't do the same thing with transport." He added: "But on the rest of the report, I don't think it was really challenged" (Black 2010). That was not how the popular press framed it (McWilliams 2010).

Major newspaper outlets repeated the claim that cows should not be blamed for climate change. Stănescu (2019) analyzed Mitloehner's press coverage and noted "universally, the story was reported as though the link between animal agriculture and greenhouse gas emissions had been disproven." Most media coverage never mentioned the funding from the Beef Checkoff (Hickman 2010; Stănescu 2019). The largest US meat industry trade association published a "Media Myth Crusher" brief claiming that the "oft-cited and deliberately 'shocking' statistic" that livestock contribute 18% to global GHG emissions had been "widely challenged by scientists" (NAMI 2015).

Mitloehner has written that "Livestock's Long Shadow" marked the beginning of the "villainizing of livestock" (@GHGGuru 2020b). *Beef Magazine* wrote that the report "galvanized cattlemen into getting more aggressive and doing something about it," including generating research and data to show that cattle production is becoming more sustainable (Rutherford 2013). Industry publications have described Mitloehner as "the scientist who debunked Livestock's Long Shadow" (Mayday 2019) and "the scientist setting the record straight on cows and climate change" (Smith 2020).

3.3 "Greenhouse gas guru"

Mitloehner has never contributed as an author to an Intergovernmental Panel on Climate Change (IPCC) report, has rarely or never presented at major climate science conferences, and publishes most frequently in animal science journals. However, after his challenge to "Livestock's Long Shadow," Mitloehner became a frequently quoted "expert" on climate change. His presence in trade publications and the popular press increased. According to a search of NexisUni for publications including the words "Frank Mitloehner" (including results from newspapers, newswires and press releases, industry trade press, magazines and journals, and web-based publications), Mitloehner was mentioned in an average of six publications per year from 2004 to 2009. In 2010, he was mentioned 59 times. In 2009, he started a blog, "GHGGuru Blog," and a Twitter account, "@GHGGuru," short for "greenhouse gas guru."

His Twitter account was rarely active until 2018, when a confidential industry memorandum of understanding prepared by an industry trade association funder noted Mitloehner's 983 Twitter followers and that Mitloehner, UC Davis, and the industry "have made significant progress on both increasing Dr. Mitloehner's messaging and exposure" (Newman 2018). Mitloehner's account now has more than 33K followers and he is a much more active user with an average of 5670 posts per year between 2018 and 2021. He has used social media to get the attention of many powerful actors, including the office of Congresswoman Alexandria Ocasio-Cortez (see Table 2), climate scientist Michael Mann (who retweeted a Mitloehner post linking to a CLEAR Center video titled "Rethinking Methane"; @GHGGuru 2020a), and Burger King, which ultimately led to a Burger King donation of $106,000 to the CLEAR Center (Boren 2022). He has also promoted the potential of technological fixes to mitigate livestock emissions, including feed additives (e.g., @GHGGuru 2021a) and anaerobic digesters (e.g., Mitloehner 2022c), while also questioning the need for reductions in herd sizes (e.g., @GHGGuru 2021b).

Table 2 Timeline of UC Davis Professor Frank Mitloehner's influence on climate discourse and policy

Year	Impact on climate discourse and policy
2009–2023	**Challenged UN FAO report, "Livestock's Long Shadow," the first global report to summarize the livestock industry's impact on global climate change** Mitloehner was frequently quoted and featured in media with descriptions such as "the scientist who debunked Livestock's Long Shadow" (Mayday 2019) and "the scientist setting the record straight on cows and climate change" (Smith 2020). According to Mitloehner, the landmark UN FAO report marked the beginning of the "villainizing of livestock" (@GHG-Guru 2020b). See Section 3.2
2009	**Trade association cited Mitloehner's research in its opposition to mandatory greenhouse gas reporting** Dairy Cares—a trade association for California's dairy industry that previously relied on Mitloehner's research in 2005 to argue against air pollution regulations in the San Joaquin Valley (AP 2005)—submitted a public comment to the EPA about their Proposed Rule for Mandatory Greenhouse Gas Reporting (Dairy Cares 2009). Dairy Cares opposed mandatory greenhouse gas reporting for livestock. The comment cited "ongoing research by Frank Mitloehner."
2012–2015	**Influenced international effort to benchmark livestock emissions** Mitloehner served as chairman of the Livestock Environmental Assessment and Performance (LEAP) Partnership, a global UN FAO project to establish benchmarks, methods, and guidelines for quantifying the environmental footprint of livestock production. LEAP was formed as a result of "industry-initiated discussions" about the negative light cast on the livestock industry by "Livestock's Long Shadow" (IFEEDER n.d.c). The American Feed Industry Association's 501(c)(3) organization, the Institute for Feed Education and Research (IFEEDER), provided $72,400 in funding support for the project (IFEEDER 2017). The resulting LEAP tool "helped the US feed industry conclude that America's livestock and poultry sectors only contribute about 4% of total US greenhouse gas emissions," according to IFEEDER (n.d.c)
2012–2015	**Advised the White House on federal policy** Mitloehner was a workgroup member for US President Barack Obama's Council of Advisors on Science and Technology. Topics Mitloehner advised on included strategies for addressing the environmental impacts of food production (CAST 2019b; Mitloehner 2021a; PCAST 2012)
2015–2016	**Wrote a white paper that industry groups say led to the exclusion of reduced meat consumption and environmental criteria from the 2015–2020 US Dietary Guidelines** Mitloehner published a non-peer-reviewed white paper, "Livestock's Contributions to Climate Change: Fact or Fiction," that stated that US livestock and poultry production only account for 4.2% of US greenhouse gases and that participating in Meatless Mondays would only decrease emissions by 0.6% nationally (IFEEDER n.d.d). Joel Newman, then president and CEO of the American Feed Industry Association (AFIA), wrote that Mitloehner's white paper was "specifically targeting the current administration, US Department of Agriculture and media" with the purpose of sharing "accurate data" on livestock emissions (AFIA 2016). AFIA shared this "study" with the USDA, the White House, and media outlets while the 2015–2020 US Dietary Guidelines were being developed (IFEEDER 2017). AFIA credited the publication with keeping an expert advisory committee's recommended inclusion of environmental criteria and reduction of meat consumption out of the final guidelines (IFEEDER n.d.d; Scudellari 2016)

Table 2 (continued)

Year	Impact on climate discourse and policy
2016	**Wrote a white paper used by industry groups to support an amendment to the defense appropriations bill that attempted to block the US armed forces from adopting "Meatless Mondays."** The Farm Animal Welfare Coalition—whose livestock industry members included the AFIA, American Farm Bureau Foundation, the National Pork Producers Council, National Milk Producers Federation, and others—lobbied the US House of Representatives to support an amendment to the defense appropriations bill to block the US armed forces from adopting "Meatless Mondays" (Kopperud 2016). AFIA called Meatless Mondays "a political ploy favored by animal rights groups, designed to increasingly erode consumer demand for meat, poultry and dairy" and included Mitloehner's white paper in its information provided to the House: "The Department of Defense is a major market for US farmers and ranchers, and to arbitrarily reduce its purchases of meat and dairy would have a serious negative economic impact on US animal agriculture. A study out of University of California, Davis, which AFIA strongly advocates, was included in information to the House" (AFIA 2016). The amendment was adopted in the House of Representatives (H.Amdt.1220 to H.R.5293 2016), but did not become part of the Senate bill (S.Amdt.4485 to S.2943 2016)
2017	**Testified about regulating air pollution from industrial dairies in Oregon** Mitloehner testified before a subcommittee of the Oregon State Legislature at a public hearing on SB197, which sought to require the state's Environmental Quality Commission to adopt rules regulating air pollution emissions from dairy confined animal feeding operations. Mitloehner testified: "In my opinion, the question at hand here in Oregon is whether the state is willing to follow the California model. Considering that Oregon air quality is comparably pristine, the question is if the state is willing to unintentionally sacrifice small farms that have a much harder time complying with stringent air quality rules. The air quality in Oregon is great, so what do you want to improve and at what cost?" (SB197 Public Hearing 2017)
2018–2023	**Founded and leads the UC Davis CLEAR Center** Mitloehner is the founding executive director of the UC Davis CLEAR Center, which has become one of the most prominent academic centers focused on livestock industry interests with respect to climate policy. In documents obtained by public records requests, the center's largest funder, IFEEDER, described the center's research as critical to "sharing the important message of animal agriculture's role as a solution provider" on national climate issues and described Mitloehner as providing "a neutral, credible, third-party voice to news reporters and stakeholder groups at conferences and other important governmental meetings" (Boren 2022; IFEEDER n.d.b)
2019	**Testified before the US Senate that the livestock industry's contributions to climate change "pales in comparison to other sectors"** Mitloehner testified before the US Senate Committee on Agriculture, Nutrition, and Forestry at a hearing titled "Climate Change and the Agriculture Sector" (Mitloehner 2019b). Mitloehner told the committee that there was a vast misunderstanding about livestock's role in climate change and that "giving up meat won't solve the problem." Mitloehner's written testimony claimed that many people wrongly believe that the livestock industry "should bear the brunt of the blame for climate change." He wrote that this "misconception" comes from Hollywood actors and from "some of our most trusted news sources—The Washington Post, The New York Times and the Guardian among them. They've printed articles and editorials espousing how detrimental animal agriculture is to Earth's well-being—even suggesting we should tax beef to deter people from eating it." The sector's climate impact "pales in comparison to other sectors," he wrote. The testimony was promoted by corporations (e.g., Merck Animal Health USA 2019; Darigold 2019) and industry trade publications (e.g., Graber 2019)

Table 2 (continued)

Year	Impact on climate discourse and policy
2019	**Spoke with Congresswoman Alexandria Ocasio-Cortez's office to "set the record straight" on a reference to livestock in a Green New Deal factsheet, which her office then removed** When Congresswoman Alexandria Ocasio-Cortez announced her "Green New Deal" plan, she released a factsheet that referenced the climate effects of "farting cows" (NPR 2019). Mitloehner tweeted at the congresswoman that reducing meat and dairy consumption is low impact "compared to the 800 lb gorilla, which is to reduce fossil fuel use" (@GHGGuru 2019c; Bloch 2019). In response, Ocasio-Cortez's staff reportedly reached out to Mitloehner to "discuss the potential for climate mitigation efforts in agriculture" (Evich 2019). Following the call, Ocasio-Cortez's office removed the reference to cows from the sheet (Splitter 2021). In media coverage of the topic, Mitloehner gave Ocasio-Cortez "credit for reaching out" and himself credit for helping "set the record straight" (Bloch 2019)
2019	**Challenged the EAT-*Lancet* report** The 2019 EAT-*Lancet* Commission synthesized scientific research to recommend shifts in diets that would improve both health and sustainability (Willett et al. 2019). The report called for significantly reducing animal agriculture. In a CLEAR Center blog post, Mitloehner called the EAT-*Lancet* report an "epic fail" that "plays on the myth that changing what we eat can drastically affect the environment," and "makes environmental claims that are misleading the public into thinking all one has to do to halt climate change is opt for a veggie burger … a claim that has no basis in science" (Mitloehner 2019a). An internal report by the CLEAR Center obtained in a public records request praised Mitloehner's social media pushback against EAT-*Lancet* and credited him with leading a "massive campaign" of 40 scientists that "was successful in swaying undecided audiences away from the EAT-Lancet report" (CLEAR 2019). "These efforts and results were largely possible because of Dr. Mitloehner's efforts to connect and communicate with colleagues around the world, who wouldn't have mobilized otherwise," according to the briefing. "This highlights the significant need for a nucleus, such as the CLEAR Center, where high-impact communication efforts can be coordinated and sparked." On social media, Mitloehner implied that EAT-*Lancet* co-author Marco Springmann is biased and called him an "activist vegan" and "very junior" (@GHGGuru 2019a, 2019b, 2020d)
2019	**Presented at industry-sponsored California state capitol briefing and "lobby day" event** The California Cattlemen's Association, Western United Dairies, and the California Teamsters Public Affairs Council hosted a briefing at the California State Capitol featuring Mitloehner "combatting commonly held misconceptions and trying to stem the tide of misinformation about livestock's global impact" (Chandler 2019). Mitloehner also presented at a "Steak and Eggs" breakfast and "lobby day" event hosted by California Cattleman where he discussed greenhouse gas emissions, the EAT-*Lancet* report, and a proposed bill that would make it possible for California public school districts to receive reimbursement for the cost of expanding plant-based meals (Freitas 2019). The California Assembly passed AB-479 in a vote of 63–12, but the bill died in the California State Senate (AB-479 2019)
2020–2023	**Promoted GWP* as greenhouse gas accounting metric** Since 2020, Mitloehner has advocated for the use of a novel GHG emissions metric, GWP*, to quantify the impact of livestock industry greenhouse gas emissions on global warming (i.e., CLEAR Center 2023a; Mitloehner 2020a; Rocha 2022; Pressman et al. 2023) as an alternative to the more commonly used metrics of GWP100 or GWP20. When GWP* uses a recent baseline and is applied at the sub-global level, the metric is favorable toward regions with stable or declining herd sizes, like the United States, and less favorable toward countries with growing herd sizes. Mitloehner presented the concept of GWP* to the UN FAO and later wrote that "they found it so intriguing, that a special task force is being assembled as we speak to deliberate on whether the world needs a new gold standard to quantify biogenic methane" (CLEAR Center 2023a) See Section 3.3

Table 2 (continued)

Year	Impact on climate discourse and policy
2020–2023	**Shaped California Air Resources Board compliance cap-and-trade program offsets protocols** California's cap-and-trade policy creates a market in which climate polluters can meet some of their emissions reduction requirements by purchasing offset credits from others who have reduced their emissions. For example, manure-to-energy projects that meet California's carbon offset protocols can be sold and traded through the state's cap-and-trade program, which is overseen by the California Air Resources Board (CARB). Mitloehner joined the CARB's Compliance Offsets Protocol Task Force in 2020, representing the stakeholder group "scientists" (CARB n.d.b). The task force provides guidance to CARB in establishing new offset protocols for the cap-and-trade program. In 2021, two members of the task force resigned, accusing members of the task force of self-dealing and conflicts of interest (Halper 2021). The state of California has significantly exaggerated the climate value of many offsets purchased and sold in its cap-and-trade program, undercutting climate progress (Elgin 2023). During Mitloehner's tenure, the task force recommended offset protocols be developed for the use of methane-reducing feed additives by cattle operators, for avoided conversion of grassland by livestock producers, and for diversion of manure storage from anaerobic systems (CARB 2021)
2020	**Co-authored report with leader of California dairy industry trade association arguing that California dairy farms are already "doing their part" to meet climate goals and will achieve climate neutrality with entirely voluntary actions and incentive-based measures** Mitloehner, along with his UC Davis colleague Ermias Kebreab, and Michael Boccadoro, executive director of Dairy Cares (a trade association representing the California dairy industry), published a UC Davis CLEAR Center white paper in September 2020 entitled, "Methane, Cows, and Climate Change: California's Dairy's Pathway to Climate Neutrality" (Mitloehner et al. 2020a). The white paper stated that California dairy farms have "already stabilized emissions" and that "as dairies continue to achieve further methane emission reductions, then they can create negative warming, also referred to as 'cooling'" (Mitloehner et al. 2020a). The executive summary claimed that California's dairy farms are already "doing their part to meet these climate goals" and that climate neutrality will be achieved with voluntary actions and incentive-based measures (Mitloehner et al. 2020b)
2021–2022	**Named author of a study prepared by a consulting firm that promoted voluntary, incentive-based approaches to reducing emissions in the dairy industry and called direct regulation of dairy emissions misguided** With funding from the California Dairy Research Foundation (CDRF 2021), Gladstein Neandross & Associates (GNA)—a California-based consulting firm specializing in energy and transportation—prepared an analysis on which Mitloehner and two UC Davis colleagues were listed as authors documenting the California dairy industry's progress reducing methane emissions, reviewing and recommending pathways for meeting the state's methane emissions reduction targets, and examining the impacts of increased regulation (Kebreab et al. 2022). The report advocated that voluntary actions and financial incentives "are currently driving voluntary dairy methane reduction in California" in line with state regulators' targets and that direct regulation of greenhouse gas emissions from the state's dairy farms or limits on dairy digester incentives would be "misguided" (Kebreab et al. 2022). Under the heading "Industry Benefit," CDRF described the project's intended impacts as "maintain voluntary, incentive-based approaches," "better respond to environmental justice criticisms," "encourage dairy methane reduction funding," and "inform and educate stakeholders on viable goals and cost-effective strategies" (CDRF 2021)

Table 2 (continued)

Year	Impact on climate discourse and policy
2022	**Testified before Ireland's national parliament that reducing animal herd sizes is impractical and counterproductive** Mitloehner testified about how methane emissions from livestock should be considered and calculated before the Joint Committee on Agriculture, Food and Marine in Ireland's national parliament, the Houses of the Oireachtas. "Reducing herd sizes isn't a practical solution, especially in Ireland, where farmers are very efficient producers," said Mitloehner. "If they scaled back their herds, production would likely move to another region so that global demand could be met. Given how proficient Irish farmers are, those picking up the slack, so to speak, may well be less environmentally sustainable than Irish farmers. This is called leakage, a phenomenon that could well lead to a spike—not a reduction—in greenhouse gas emissions." Mitloehner also said more information is needed on how much carbon is being sequestered by Irish farms and promoted the value of "real, workable" solutions to emissions in California such as anaerobic digesters and feed additives (Mitloehner 2022b)
2023	**Met with New Zealand government officials and MPs, where he advocated for "carrots" for livestock producers instead of "sticks"** Beef + Lamb New Zealand (2023) paid for Mitloehner to visit New Zealand. During the trip, Mitloehner met with farmers, scientists, and government officials, including members of parliament, the Climate Change Commission and the Ministry of Primary Industries (@ GHGGuru 2023a), and delivered public talks at universities. According to B+LNZ (2023): "In his lectures and meetings with Government officials and MPs, Dr Mitloehner explained that methane only needs to be reduced and does not need to go to zero. He said targets for agricultural sectors across the world should aim to be climate neutrality*, not carbon zero." The Chief Executive of B+LNZ said: "Dr Mitloehner's strong message to the Government was that it needs to work with farmers and not against them, and that a carrot approach was much more effective than the stick."
2023	**Met with Australian policymakers and spoke at industry-hosted and government-hosted events on greenhouse gas accounting methods** Mitloehner traveled to Australia, where he met with "policy makers and influencers" (@ GHGGuru 2023b), presented lectures hosted by the Western Australia's Department of Primary Industries and Regional Development (Western Australia Government 2023) and industry groups (Food + Fibre Great South Coast 2023) on topics including greenhouse gas accounting methods and the importance of communicating how the livestock industry can be a climate solution, and gave media interviews (Barker 2023)

The industry has not only helped promote Mitloehner as a climate expert in traditional and social media, but also in policy discussions both in the USA and abroad (Table 2). Mitloehner has written white papers that industry groups used to advocate for the exclusion of reduced meat consumption from the 2015–2020 US Dietary Guidelines and to support an amendment to the defense appropriations bill that attempted to block the US armed forces from adopting "Meatless Mondays." In 2019, Mitloehner testified before the US Senate Committee on Agriculture, Nutrition, and Forestry at a "Climate Change and the Agriculture Sector" hearing where he said the livestock industry's contributions to climate change "pales in comparison to other sectors." He has also spoken before Ireland's national parliament, met with government officials in New Zealand and Australia, and participated in industry-hosted lobbying events at California's state capitol (Table 2).

Mitloehner has argued for the metric GWP* to quantify the impact of livestock industry greenhouse gas emissions on global warming (e.g., CLEAR Center 2023a; Mitloehner 2020a) and has said that "adopting GWP* could be a revolutionary change to efforts within animal agriculture" (CLEAR Center 2020b). The commonly used metric GWP100 provides an estimate of the warming impacts of a gas over a 100-year time period relative

to an absence of emissions; GWP20 functions the same way over a 20-year period. GWP establishes equivalences between CO2, a long-lived climate pollutant, and short-lived climate pollutants, like CH4, in order to estimate their combined warming impacts in a single measure, but these equivalencies do not perfectly reflect how short-lived climate pollutants like CH4 change the surface temperature over time (Allen et al. 2016). This is because "1 tCO2eq of CH4 does not cause the same amount of warming at all times as 1 tCO2eq of N2O or CO2" (UN FAO 2023b).

GWP* was proposed as a new way to estimate the warming impacts of short-lived and long-lived climate pollutants (Allen et al. 2018; Cain et al. 2019; Lynch et al. 2020). While GWP represents the marginal contribution of an activity to climate change, GWP* represents the contribution of "additional" emissions to climate change relative to the emissions of a specified starting date (UN FAO 2023b). GWP*'s approximation of the warming impacts of emissions therefore depends significantly on the selected baseline. At the global level, GWP* is considered a better predictor of global-mean temperature change than GWP (Meinshausen and Nicholls 2022), but its use at sub-global levels for climate mitigation policymaking has raised concerns about inequity—particularly when used with a recent baseline—and is highly debated among scientists (Rogelj and Schleussner 2019; Meinshausen and Nicholls 2022; Hayek et al. 2023; Donnison and Murphy-Bokern 2023).

Studies published in agricultural journals have used GWP* as an alternative to GWP100, rather than as a complement, to produce findings that are favorable to the livestock sector (Donnison and Murphy-Bokern 2023). For example, Mitloehner co-authored a paper that used GWP* to conclude that the US dairy industry could reach climate neutrality by 2050 with only minor methane reductions (Place et al. 2022) and another that stated that California's dairy industry could "induce cooling" if it mitigates methane by more than 1% per year (Liu et al. 2021).

In CLEAR Center white papers and in agricultural journal articles, Mitloehner has argued using GWP* that, without reducing herd sizes, the California dairy sector could achieve climate neutrality before 2030 (Mitloehner et al. 2020a, co-authored with the executive director of a dairy trade association; McCabe et al. 2023) and the US beef and dairy sectors could achieve climate neutrality before 2050 without reducing herd sizes (Place and Mitloehner 2021). Mitloehner has also advocated for GWP*'s adoption in public policy. In 2020, the European Commission issued a call for evidence on a new methane strategy and Mitloehner submitted a comment on behalf of the CLEAR Center discussing the merits of GWP* and stating that GWP* "is a more accurate system of measuring the actual warming potential of short-lived climate pollutants over time" (Mitloehner 2020b). See Table 2.

3.4 Mitloehner's industry funding

According to his CV dated April 2021, Mitloehner (2021a) has received $5,498,000 in research funding from industry groups since 2002. This amount represents 46% of his total reported $12,066,300 funding during that time period. His industry funders include the National Pork Board, National Cattlemen's Beef Association, Eli Lilly, Elanco Animal Health, Center for Food Integrity, DeLaval, Novus International, and Alltech. Notably, his CV on the UC Davis website omits multiple industry funding sources noted elsewhere, including the $26,000 from the Beef Checkoff program in 2009 (Wright 2009), funding from the trade association Dairy Cares in 2006 for a study measuring cow emissions (University of California Cooperative Extension 2006), and a grant of $200,000 from the National Cattlemen's Beef Association in 2019 reported on the CV of one of his former PhD students (Werth 2021). The

CLEAR Center reported in December 2021 that Mitloehner also led research funded by Zoetis, though Zoetis does not appear on his April 2021 CV (Sharpnack 2021).

Mitloehner's CV also does not disclose financial and professional ties to industry groups beyond his academic role. For example, in its Form 990, the Institute for Feed Education and Research (IFEEDER), the nonprofit arm of the American Feed Industry Association (AFIA), paid "Mitloehner Consulting" $18,993 in the fiscal year ending in 2018 for "research in accordance with the institute's mission" (IRS 2018). While not on his CV, according to the online database OpenCorporates, as of 2019, Mitloehner was a listed director of Distributors Processing Inc., a livestock feed additive company that is privately held (OpenCorporates 2019).

Mitloehner's industry funding is often not disclosed in his publications. A recent publication with Place et al. (2022) on "defining a pathway to climate neutrality for US dairy cattle production" acknowledged only Place's employment with Elanco Animal Health and declared "the authors have not stated any other conflicts of interest." Eli Lilly, a pharmaceutical company that then owned Elanco Animal Health until 2019, gave Mitloehner $4,000,000 in grant funding between October 2012 and November 2017 (Mitloehner 2021a)—by far the largest grant on his CV —but a Web of Science search in May 2023 returned zero Mitloehner publications since 2012 that acknowledged either Eli Lilly or Elanco Animal Health. Mitloehner's testimony to the US Senate also did not mention his industry funding (Mitloehner 2019b), although, unlike the US House of Representatives, the US Senate does not require nongovernment witnesses to disclose potential conflicts of interests with testimonies (Graham 2021). Mitloehner's disclosure statement alongside his byline on the website *The Conversation* in 2018 only included funding from California Air Resources Board and California Department of Food and Agriculture (Mitloehner 2018). Even *The New Yorker*, with its rigorous fact-checking, quoted Mitloehner in an article about plant-based burgers, but only noted that Mitloehner is "often cited by pro-meat forces," but not his financial ties to industry (Friend 2019).

In addition to his research, public outreach, and advocacy, Mitloehner has trained at least half a dozen PhD students with industry funding (ESM 2). Three of his former students went to work as Air Pollution Specialists for the California Air Resources Board (CARB n.d.a), the state agency "charged with protecting the public from the harmful effects of air pollution and developing programs and actions to fight climate change." Mitloehner (2021a) listed $1.59 million in funding from CARB since 2012 (the agency is acknowledged in two of Mitloehner's refereed articles). Many of his students also go to work directly for industries from which Mitloehner received funding (ESM 2). Three former students, including Stackhouse-Lawson, have served in sustainability leadership roles at the National Cattlemen's Beef Association (ESM 2).

3.5 The CLEAR Center and Mitloehner's "neutral, credible, third-party voice"

In 2018, Mitloehner was named the founding director of the UC Davis CLEAR Center, which has received millions of dollars in industry funding and funding commitments. IFEEDER, an arm of AFIA, the largest trade organization in the world devoted to representing the business interests of the US animal food industry and its suppliers, is reportedly the main donor with gifts and gift commitments of $2.88 million (Fig. 1; Boren 2022). AFIA's members include over 650 companies and manufacture over 75% of livestock feed in the USA (AFIA et al. 2022). IFEEDER's (2022) largest donors include Alltech Inc., WATT Global Media, Cargill Animal Nutrition, and Elanco Animal

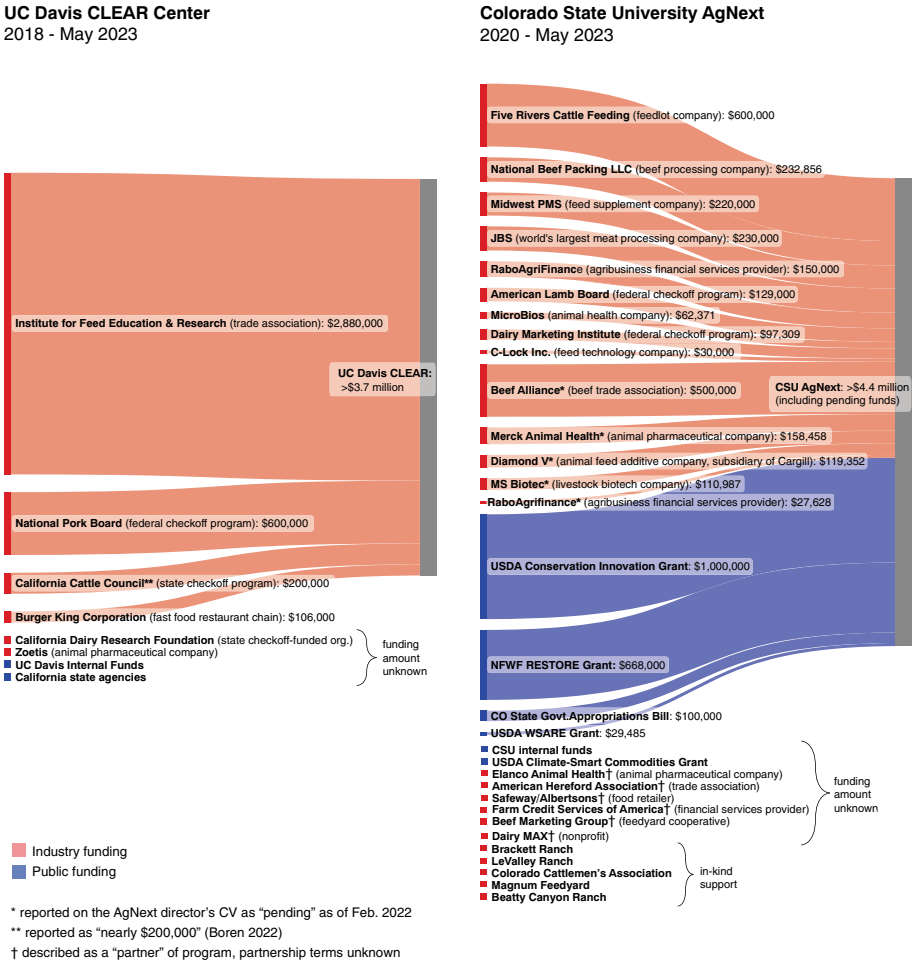

Fig. 1 Known funding streams for the UC Davis CLEAR Center (from founding in 2018 to May 2023) and Colorado State University AgNext at CSU (from founding in 2020 to May 2023). Note that this figure also includes funding for research related to the center's purpose and for which the center faculty director was a principal investigator or co-principal investigator during the same time period. These figures do not include funding sources announced in 2023 after the date of article submission. See ESM 3 for data and sources

Health, with each having given at least $250,000 to qualify as "chairman's" or "diamond" donors (IFEEDER n.d.a, n.d.e). Other major IFEEDER donors include Church & Dwight Company Inc., Darling Ingredients Inc., Distributors Processing Inc. (where Mitloehner is listed as a director, according to OpenCorporates 2023), Land O'Lakes Inc., and Zinpro Corporation (IFEEDER 2022). Other CLEAR donors include the National Pork Board ($600,000), the California Cattle Council ("nearly $200,000"), and Burger King Corporation ($106,000) (Boren 2022; CLEAR Center 2023b).

IFEEDER retained the PR firm Charleston/Orwig (now rebranded as C.O.nxt) to help name the CLEAR Center. Documents Boren (2022) obtained via public records requests showed IFEEDER was involved in envisioning the center from its inception

and is regularly involved in CLEAR Center activities. In addition, CLEAR seemingly did not disclose all of its funding sources in the center's early years. A Wayback Machine screen capture from October 21, 2020, showed the CLEAR Center website mentioned financial support only from "the College of Agricultural and Environmental Sciences, University of California Agriculture and Natural Resources, and philanthropy" (CLEAR Center 2020a). After public record requests were filed, CLEAR added a section—"About CLEAR Center funding"—that noted IFEEDER as a funder (but not the funding amount) along with the statement: "IFEEDER's support does not influence the CLEAR Center's research." The CLEAR Center advisory board reportedly includes twelve animal agriculture industry representatives. Cargill, Elanco Animal Health, Alltech, AFIA, and NAMI all reportedly hold seats on the board (Boren 2022), but the names of the individual board members are not publicly disclosed. The advisory's board existence was also only disclosed on the CLEAR website in mid-2022 after the center received a public record request (Boren 2022).

IFEEDER (n.d.b) described the CLEAR Center's "objective research" as "critical for the IFEEDER to reference when sharing the important message of animal agriculture's role as a solution provider in the nation's efforts to address climate change issues." IFEEDER (n.d.b) wrote that its parent organization, AFIA, "will share research findings in policy discussions happening within international standard-setting bodies and at the national level, shaping the future outlook for the industry. Mitloehner provides a neutral, credible, third-party voice to news reporters and stakeholder groups at conferences and other important governmental meetings. The data will show consumers that they can feel good about the choice they are making to include protein in their families' diets." According to the briefing, the CLEAR Center was designed to share its work "with decision makers, thought leaders and consumer influencers" and "to showcase the feed industry's commitment to continuous improvement in sustainability."

In line with IFEEDER's stated objectives, one of the CLEAR Center's activities is to promote Mitloehner's prolific writing, media interviews, and presentations related to livestock emissions (Table 2). As of May 2023, the "research" tab on the CLEAR website links only to Mitloehner's ResearchGate profile. There are no refereed papers that acknowledge the CLEAR Center for funding. CLEAR self-publishes a series of technical "explainers" and links to Mitloehner's blog, which includes posts with titles such as "The bogus burger blame" and "When did beef become a four-letter word?" (Mitloehner 2021b, 2022a). CLEAR, funded largely by the feed industry, also researches and promotes feed additives as a climate change solution (e.g., Sharpnack 2021). We provided examples of four claims Mitloehner and the CLEAR Center have made about climate change and the livestock industry as well as supporting evidence for why these claims can be misleading. See Table 3.

3.6 What is next? AgNext and Kimberly Stackhouse-Lawson

In December 2019, CSU announced a new initiative for livestock sustainability research in partnership with the Colorado Beef Council, Colorado Cattlemen's Association, Colorado Farm Bureau, and the Colorado Livestock Association (Giordano 2019; Courage 2020). The student newspaper reported that "the driving force behind much of the research conducted by the collaborative will be issues posed to CSU by [industry] professionals" (Bettis 2020). In October 2020, CSU hired Stackhouse-Lawson as a full professor of animal science and the first director of the initiative (Courage 2020), which in 2021 was named AgNext.

Table 3 Examples of four potentially misleading claims made by Mitloehner (@GHGGuru) and/or the UC Davis CLEAR Center (@UCDavisCLEAR) on social media

Claim	Examples	Evidence for why the claim can be misleading
Animal agriculture isn't a major driver of climate change compared to fossil fuels	*"Are cows the new coal? In short: No. Longer: HECK NO! Red herring headlines like in this @cnn article exaggerate the impact of animal agriculture, while minimizing the impact of fossil fuels. 1/* https://www.msn.com/en-us/weather/…" (@GHGGuru 2021c) *"Fossil fuel emissions are really where the climate music plays primarily— and they are trending in the wrong direction globally. Ag emission reductions of methane can have a modest impact on slowing warming but nothing comes close to the need of ceasing FF impacts.* https://t.co/OZl8G5Pwq1" (@GHGGuru 2022a)	Even if fossil fuel use ended immediately, food production emissions are on course to drive global temperatures beyond 1.5 °C above pre-industrial levels (Clark et al. 2020; Ivanovich et al. 2023). Animal-based foods account for an estimated 57% of food production emissions (Xu et al. 2021). Globally, livestock supply chains are estimated to emit about one-third of all human-caused methane emissions, the largest anthropogenic source (Shindell et al. 2021)
Reducing US meat consumption would make only a modest climate impact	*"And the 'cut meat, save the planet' messaging is just that. A distraction from the real issue. Did you know, if Americans eliminated meat from their diet GHG emissions would drop by only 2.6%? An honorable effort but we're in an emergency, folks. More:* https://t.co/dvzfh4QQKh" (@GHGGuru 2020e) *"If Americans stopped eating meat, it wouldn't do much to save the planet. We need to shift this narrative if we're serious about slowing warming. Let's begin by seeing cattle as partners in #sustainability and climate change mitigators.* https://t.co/wyMJBD6v96" (@UCDavisCLEAR 2020)	White and Hall (2017) estimated that if Americans stopped consuming livestock, it would reduce GHG emissions by 2.6%. However, this study was widely criticized for failing to account adequately for feed crops and for relying on "highly unrealistic and narrow scenario design" (i.e., Springmann et al. 2018; Van Meerbeek and Svenning 2018; Emery 2018). Eshel et al. (2016) estimated that replacing beef with plant-based foods in American diets would save 220 to 335 million tons of CO_2e per year, approximately 4% of total emissions. Given the US's status as one of the largest emitters in the world, either estimate is arguably significant. While agriculture represents a smaller percentage of total US emissions than transportation or energy as measured in CO_2e, it represents the largest relative source of US methane emissions (36%) (US EPA 2021). It is also important to note that reporting greenhouse gas emissions as CO_2e over a 100-year time horizon systematically underestimates the warming contributions of methane-dominated economic sectors such as agriculture (Cohen-Shields et al. 2023)

Table 3 (continued)

Claim	Examples	Evidence for why the claim can be misleading
Methane from cattle does not have the same warming impact as methane from fossil fuels	*"THREAD: Does methane from cattle have the same warming impact as methane from fossil fuels? The answer is NO, but that's the popular belief. Through science we will #rethink-methane AND help curb the climate crisis. 1/"* (@GHGGuru 2020c) *"Not all methane is created equal. Fossil fuels release previously sequestered carbon into the atmosphere. Cattle recycle carbon as part of the biogenic carbon cycle. Learn more* 👇👇👇👇 *https://t.co/ry0t8OoFUD"* (@UCDavisCLEAR 2022)	"Biogenic methane" (methane produced and released by living organisms) has nearly the same atmospheric warming impact as fossil methane. After about 12 years in the atmosphere, both types of methane combine with oxygen to form CO2 and water. For fossil methane, the IPCC considers the CO2 produced by this process as an added molecule of fossil CO2. For biogenic methane, the CO2 produced is not counted as additional since it originally had a non-fossil carbon source (Forster et al. 2021). As a result, fossil methane has slightly higher emissions metric values (29.8 for GWP100) than biogenic methane (27.2 for GWP100), but the difference is considered relatively minimal
Reducing cattle herd sizes is unnecessary because livestock industry-favored technologies, such as feed additives and anaerobic digesters, are effective solutions to the industry's emissions	*"People are hyper focusing on the digester example to distract from my message: We can reduce livestock GHGs & meet food demand. Some are convinced that to reduce GHGs, herd sizes need to shrink. But as CA shows, there are other ways to reduce GHGs. It's just one example. 12/12."* (@GHGGuru 2022b) *"What I have always wondered about is why folks always want to reduce herd sizes. There a so many ways to mitigate emissions* via *feeding, breeding, housing, manure management* etc. *IMO, we will reduce livestock methane by 40% in the next 10 yrs."* (@GHGGuru 2021b)	The Global Methane Assessment's analysis of the potential for technological measures to address methane emissions found they had "limited potential," with estimates ranging from 4 to 42 Mt of methane per year. While technologies such as feed additives can help mitigate emissions and, their mitigation potential should not be dismissed, even the most optimistic projections indicate that technological interventions alone—which focus on reducing emissions intensity—are insufficient to account for projected increases in absolute emissions (Shindell et al. 2021)

Stackhouse-Lawson completed her PhD in Animal Biology in 2011 at UC Davis under Mitloehner's supervision and with research funding support from beef trade groups (Stackhouse 2011). From 2011 to 2016, she worked as Executive Director of Global Sustainability for the National Cattlemen's Beef Association (NCBA), one of the country's largest animal agriculture lobbying groups with a history of lobbying against climate legislation (Lazarus et al. 2021). By her own account, the NCBA role involved "collaborating closely with communications professionals to promote beef's image and defend beef's freedom to operate to enhance consumer, influencer and stakeholder trust in beef" (Stackhouse-Lawson 2020).

From 2016 to 2020, Stackhouse-Lawson was Director of Sustainability for JBS USA, a subsidiary of the world's largest meat processing company. In 2020, Stackhouse-Lawson stated that her "primary career objective is to expand the role of animal protein in global diets" (Stackhouse-Lawson 2020). Stackhouse-Lawson has said removing meat from our diets would result in negligible greenhouse gas reductions (Anderson 2019) and that "meat-free diets are not the solution" (Stackhouse-Lawson 2021a). In March 2021, 6 months after Stackhouse-Lawson left JBS to join CSU, JBS (2021) announced a commitment to achieve net-zero greenhouse gas emissions by 2040. This commitment to consumers was criticized for not being substantiated with the operational plans needed to meet the commitment (BBB National Programs 2023). A $230,000 donation to CSU AgNext was featured on the company's net-zero website (JBS n.d.).

In June 2022, Stackhouse-Lawson told *Meatingplace Magazine* that "my day to day [at CSU] is not so different than what it was at JBS" (Ricci 2022). In her role as Director of AgNext, Stackhouse-Lawson has overseen the fundraising and growth of one of the largest university centers in the country focused on climate change and animal agriculture. In 2021, Stackhouse-Lawson gave a presentation to industry leaders seeking $4.5 million in funding (AgNext and Five Rivers Cattle Feeding 2021) and has received at least $750,000 as of May 2023 from industry groups, including Five Rivers Cattle Feeding (the largest standalone cattle feeding business in the world), National Beef Packing Company LLC (a beef processor), Midwest PMS (a feed supplement company), Rabo AgriFinance (an agribusiness financial services provider), Dairy Marketing Institute (a producer-funded federal checkoff program), American Lamb Board (a producer-funded federal checkoff program), and JBS, Stackhouse-Lawson's former employer (Stackhouse-Lawson 2022; Fig. 1; ESM 3).

AgNext's website (n.d.) lists an "industry innovation group," which provides "input on strategic initiatives and programs, acts as a soundboard for new ideas and opportunities, promotes AgNext in the livestock community, helps recruit talent and elevates AgNext on a global scale." As of May 2023, the majority of the advisory board are leaders of companies that appear to have funded AgNext (ESM 3). According to an off-the-record presentation by Stackhouse-Lawson to the Farm Foundation that was published online, the industry board also reviews communication plans and initiatives and provides input on research planning (Stackhouse-Lawson 2021c). Current and former innovation board members include the Head of Corporate Affairs and Chief Sustainability Officer of JBS USA, the Executive Vice President of RaboBank, and the CEOs of Beef Marketing Group and Five Rivers Cattle Feeding (AgNext n.d.).

AgNext has formed multiple industry partnerships. In 2022, after AgNext announced that it was engaging in cooperative research with the American Hereford Association, the organization's former executive vice president, who then became director of equine sciences and elite bovine and equine genetics at CSU said, "This is going to help us maintain the license to operate" (AHA 2022). In 2023, after AgNext announced a new

"strategic alliance" with Dairy MAX, a dairy council representing 900 dairy farms across seven states, CSU's press release stated that the strategic alliance "highlight[s] how progressive the agriculture industry is" (AgNext 2023d).

From her academic position, Stackhouse-Lawson has also sought and secured government funding for AgNext. The Colorado General Assembly's 2022–23 appropriations bill was amended before it passed to include $100,000 in general support for the "AgNext Climate Change Program at Colorado State University" (Goodland 2022; FY 2022–23 Legislative Appropriations Bill 2022; ESM 3). In 2022, Colorado congressmen submitted a $1.35 million funding request to support AgNext (website of Sen Michael Bennett, n.d.; website of Rep. Joe Neguse, n.d.), although the request was not included in the final bill (US Senate Committee on Appropriations 2022). In 2022, CSU announced that Stackhouse-Lawson received funding for a project led by Tyson Foods and funded by a USDA Partnership for Climate-Smart Commodities grant that "will expand climate-smart markets and increase carbon sequestration and reduce emissions in the production of beef and row crops for livestock feed" (Polakovic 2022). In 2023, AgNext received a $1,000,000 grant from the USDA to "generate science-based estimates of CO2-equivalent (CO2e) emissions from livestock grazing and finishing sectors" and "evaluate potential CO2e reductions from conservation practices" (AgNext 2023b).

Stackhouse-Lawson has also engaged directly on policy issues, including providing testimony to US Congress in 2022 (Stackhouse-Lawson 2022). At the hearing, Stackhouse-Lawson told the US House of Representatives Subcommittee on Livestock and Foreign Agriculture that the livestock industry has been "dedicated to continuous improvement for several decades and has already set audacious net zero emission goals across multiple livestock sectors" and said actions to enhance sustainability should only be implemented if they do not sacrifice "value chain profitability."

Stackhouse-Lawson has also engaged with policy indirectly. When, in 2022, the animal agriculture industry opposed the US Securities and Exchange Commission's (SEC) proposed rule that would require publicly traded companies to disclose their scope 1, scope 2, and scope 3 greenhouse gases (NCBA et al. 2022), Stackhouse-Lawson said in an interview that she was concerned that the SEC regulations "would unduly burden our producers with a strategy that may or may not work" and that she would prefer a "win–win" climate strategy "so that producers aren't unduly burdened financially" (Fence Post 2022). She has also been involved in efforts to shape the allocation of public research funding. She participated as an author on a "research strategy to move US agriculture to net negative carbon emissions" sponsored by the US Farmers and Ranchers Alliance and the Foundation for Food and Agriculture. According to the CV that Stackhouse-Lawson (2022) submitted with her congressional testimony, the publication was slated to be reviewed by the Board on Agriculture and Natural Resources of the National Academies of Science, Engineering, and Medicine and "we anticipate this document will have a high impact on future research priorities across many agencies and organizations in the next decade and is especially timely as the next US Administration begins its plans."

Since its inception, AgNext has regularly hosted visits from policymakers. In 2022, AgNext hosted US Senator Michael Bennett (Crook 2022a), US EPA Deputy Director Janet McCabe and EPA staffers (Gerber 2022), State Representative Andrew Boesnecker, and US Senator John Hickenlooper (Giesenhagen 2022). In 2023, AgNext hosted US Congressman Joe Neguse for a Farm Bill "listening session" and US Congresswoman Yadira Caraveo, who sits on the House Agriculture Committee, for a tour of AgNext's research facility (AgNext 2023c; press release for Rep. Yadira Caraveo 2023).

In fall 2022, AgNext announced it would hire 12 tenure-track faculty members (Armbrister 2022). In 2022, Elanco Animal Health, a leading animal pharmaceutical company, and CSU announced a "strategic alliance to further transform sustainability into the next era of opportunity for livestock producers." As part of this alliance, CSU hired Elanco Animal Health Chief Sustainability Officer Sara Place as an associate professor (Elanco Animal Health 2022; CSU 2022). Place's doctoral dissertation, which was advised by Mitloehner and at least partially funded by Elanco, examined the effectiveness of adding an Elanco product (monensin; a supplement used to help increase milk production) to dairy cattle feed to reduce methane emissions (Place 2012).

AgNext worked with the public relations firm Burson Cohn & Wolfe (BCW) to build its website and online identity (Crook 2022b), and two BCW executives traveled to Fort Collins in early 2023 to provide the AgNext team with media training (AgNext 2023e). Stackhouse-Lawson (2021c) has stated that a key area of emphasis of AgNext is to "enhance external communication of complex topics and engage with influential stakeholders and policymakers in livestock systems sustainability and related fields." In an invitation-only presentation to industry leaders, one of her slides read: "A shift in strategy is needed from defensive to proactive where we come together to address the greatest challenge of our time. We have to demonstrate credibility to connect emotionally" (Stackhouse-Lawson 2021c).

AgNext produced an infographic that was shared across social media platforms themed "Colorado Protein Feeds the World" (AgNext 2021a). The messages included "animal protein is key to human nutrition" and "reducing emissions is everyone's responsibility," alongside a graphic indicating that the US animal agriculture sector's emissions are small compared to other sectors. AgNext also published a factsheet, "Quick Facts on Cattle Climate Impacts," that promoted GWP* as "more accurate" than GWP100 for measuring the warming impacts of methane over time, stated that "cattle are upcyclers of lower quality forages" and part of the climate solution because carbon is sequestered on rangelands, and stated that "meat is part of a healthy diet" (AgNext 2021b).

In 2022 and 2023, AgNext and Stackhouse-Lawson were featured in JBS-sponsored content (n.d., 2022a, 2023) in *The Wall Street Journal* and *Politico*, as well as a JBS-sponsored *Reuters* webinar (JBS sponsored content 2022b). These advertisements do not mention that Stackhouse-Lawson is a former JBS executive and refer to her only by her academic affiliation with CSU. AgNext included the JBS sponsored content in *The Wall Street Journal* and *Politico* under the "AgNext in the News" section of its newsletters (AgNext 2022, 2023f).

3.7 A systematic evaluation of Mitloehner and Stackhouse-Lawson

In addition to the descriptive work above and in the tables, we evaluated Mitloehner and Stackhouse-Lawson according to a set of 20 questions that we developed aimed at better understanding the nature, extent, and impacts of individual researchers' relationships with industry funders. Mitloehner received a score of 19 and Stackhouse-Lawson a score of 15, both of which indicate possible concerns about the independence of the researcher. (For answers and supporting evidence for all 20 questions, see ESM 1.)

Both researchers have received significant research funding from industry groups (Q1); both lead university centers that receive funding from industry groups (Q2); both have been employed by an industry group (though the extent of consultancies, if any, is opaque; even when it is clear a university researcher consults with industry, the nature of the work and the dollar amounts received are rarely available) (Q3); both have received awards or

travel from industry groups (Q4); both have failed to disclose industry funding in instances where it is the norm to do so (Q5); both have testified before US Congress (Q7); both have presented to policymakers at an industry-sponsored event (Q8); both have work that was referenced in public comments submitted by industry groups to regulatory agencies (Q10); both have co-authored publications with industry employees (Q11); both have published repeatedly in industry-funded journals (Q12); both have been referenced by industry groups in industry advertisements (Q14); both have published traditional (Q15) and social media (Q16) in support of industry interests; both have minimized the industry's role in climate change (Q18); and, finally, both have challenged the need for regulations or promoted policy changes in ways that are favorable to industry (Q20; Table 1; ESM 1).

In addition, Mitloehner has been appointed to governmental and intergovernmental entities tasked with recommending or establishing methods, metrics or targets, research priorities and funding allocations, and/or policies in which the industry has financial interests (Q6) (including as a working group member of the US President's Council of Advisors on Science and Technology, as chairman of the UN FAO's Livestock Environmental Assessment and Performance Partnership, and as a member of the California Air Resources Board's Compliance Offsets Protocol Task Force); has been retained as an expert witness to defend or advance industry interests in a legal proceeding (Q9); has allowed an industry-funded consulting firm to prepare analysis under his name (Q13); and has made ad hominem attacks against individuals who have brought attention to the livestock industry's contributions to climate change (Q19). We found no evidence that either Mitloehner or Stackhouse-Lawson has challenged the existence of or minimized the significance of climate change (Q17; Table 1; ESM 1).

4 Discussion

In 2006, the animal agriculture industry was confronted with the first global estimate of the livestock sector's contribution to anthropogenic climate change. Consistent with other industries, including tobacco and fossil fuels, the animal agriculture industry's response to evidence that its product caused harm was to push back. The industry employed the help of universities. Industry-funded university-based researchers and centers have helped downplay livestock's contributions to climate change, increase public trust that the industry is proactively reducing emissions on its own accord, and shape climate policymaking in the industry's favor. Despite more than 15 years of research attributing significant climate change impacts to animal agriculture, US policies to mitigate the climate impacts of livestock emissions remain insufficient and dominated by industry-supported financial incentives that are voluntary and taxpayer-subsidized.

4.1 The researchers

When confronted with more and more research that showed that tobacco caused cancer, Brandt (2012) pointed out that the tobacco industry's response included seeking experts with a "scientific pedigree, national standing, and propensity for public conflict." The details of Mitloehner's rise to prominence show that in the twenty-first century, it was possible for the animal agriculture industry to help build a reputation of scientific credibility on topics related to climate change and attract national attention for individuals for whom little to none previously existed. Mitloehner and Stackhouse-Lawson have Ph.D. degrees in

animal science, rather than in climate-related sciences, such as geophysics or geochemistry, and are professors in animal science departments.

While receiving industry funding, both Mitloehner and Stackhouse-Lawson have been outspoken about livestock's contributions to climate change, as well as climate policies (Tables 1, 2 and 3; ESM 1). As faculty in departments of animal science, their specific careers would not exist without the livestock industry and depend upon its continuation. The existential threats climate change poses to the livestock industry are shared by animal science departments and, by extension, the individuals who conduct research within them. To the extent Mitloehner and Stackhouse-Lawson publish peer-reviewed research related to climate change, their work focuses primarily on the use of feed additives or other technological and industry-led solutions, or promoting greenhouse gas accounting metrics that are favorable to the US meat and dairy industries (i.e., GWP*).

But it would be a mischaracterization to describe the overarching issue in simple terms of potential bias due to "industry-funded research" given the time they each spend on public relations and political advocacy. Mitloehner has given more than 800 presentations since he joined UC Davis in 2002 (UC Davis Dateline Staff 2019), travels internationally to meet with government officials, and gives frequent media interviews (Table 2). In 2021, Stackhouse-Lawson gave at least 90 presentations (an average of almost two per week) related to livestock sustainability to industry groups, state agencies, and governmental organizations (AgNext 2021c). She has emphasized "that beef has a good story" (Anderson 2019) and that companies are massively improving and on track to be sustainable via voluntary actions. CSU hired Stackhouse-Lawson in 2020 as a full professor with just six first-authored research articles. In 2020, she published zero peer-reviewed articles in 2020 and, in 2021, just one (on which she was second author).

Mitloehner (Table 2) and Stackhouse-Lawson have both been involved in advancing policies that support the animal agriculture industry's interests. Mitloehner attended federal and state lobbying events on Capitol Hill (Mitloehner 2011) and in Sacramento (Chandler 2019), as well as meetings with US congress members (@GHGGuru 2018a) and state policymakers (@GHGGuru 2019e). AgNext has hosted federal and state elected officials. Both Mitloehner and Stackhouse-Lawson have given congressional testimony related to animal agriculture and climate change. Mitloehner has also testified at least once at a local hearing. Transcripts and databases for searching for local and state testimonies are less easily available than for federal testimonies, which is a limitation in searching for evidence of whether the individual has testified at a sub-national government hearing.

4.2 The universities

Universities offer legitimacy to individual researchers that the companies cannot, and that is because the mission of a university is distinct from that of a company. Public universities, especially their faculty (who also serve as teachers and administrators of the university, as well as editors and reviewers for scholarly journals), are supposed to function as part of the country's bedrock of knowledge and to serve the public interest through education and research. The university mission is at risk when universities allow industries to shape research and fund communications with the appearance of academic independence and without public knowledge of the full extent of the industry's involvement.

CLEAR and AgNext were each established by land-grant universities in states with large animal agriculture industries (California is the largest dairy producer of the US states) with

funding from animal agriculture industry groups and branding help from PR firms. Industry donors appear to be heavily involved in the operations of both centers. One of us (JJ) was involved as deputy director for a university center and the other (VM) is an executive director of a university program. Our center and program also have donors, but none are corporations or trade associations. Members from the donor organizations do not write the mission statements, sit on an advisory board, or pay for sponsored content in major media outlets featuring these institutions. The donors did not hire a PR firm to help name or publicize these institutions or to train faculty and staff. The donors do not review research agendas, amplify center publications, or share research with policymakers and lobbyists.

UC Davis and CSU are enabling the CLEAR Center and AgNext, and by extension the industries that support them, to engage in substantial public relations efforts and are allowing their university names to lend credibility to those activities. The universities may justify industry funding on the grounds that public funding for agricultural research is declining (e.g., Clancy et al. 2016; Nelson and Fugile 2022), but this should not mean that donors can use universities' resources and reputations to advance their private interests. CSU's mission statement states it is "committed to excellence… for the benefit of the citizens of Colorado, the United States and the world" (CSU n.d.).

The universities have also not required the individual faculty or the centers to disclose to the public their industry ties. The motto of UC Davis is *fiat lux* or "let there be light." Yet when a *New York Times* reporter asked the university about the CLEAR Center's industry funding, UC Davis provided no comment (Tabuchi 2022).

4.3 The industry

Industry communications reveal satisfaction with their investments in CLEAR and AgNext. In 2019, Mitloehner received an industry-funded communications award for "enlightening the public and policymakers alike" (CAST 2019a). Having witnessed Mitloehner's success, the animal agriculture industry now appears to be attempting to replicate it by supporting the academic work of Mitloehner's former students, Stackhouse-Lawson and Place. JBS and Elanco appear to have recognized that their top sustainability executives are more valuable to the industry in academic positions than in the companies themselves and donated money to support their former employees' work at CSU AgNext.

Like the animal agriculture industry, the fossil fuel industry has also funded universities with the aim of influencing climate change research, the full extent of which is unknown. Documents show that the American Petroleum Institute, for instance, gave $622,490 of funding to UC Davis between 2006 to 2017 (Ladd 2020). For comparison, IFEEDER made a gift commitment of more than four times that amount to establish the CLEAR Center.

Animal agriculture firms are, also like oil and gas firms, relying on PR firms in these university efforts. The PR firm Charleston/Orwig, which IFEEDER hired to help name the CLEAR Center, worked with Exxon in the late 1990s, and now also represents Elanco Animal Health and NCBA (Hermann 2023). BCW, a PR "pioneer in using third party voices to burnish corporate images" on environmental issues (Brulle and Werthman 2021), was hired to help launch and train professionals at AgNext. BCW is known for deep ties to the tobacco industry and oil and gas companies, including American Petroleum Institute, BP, Business Roundtable, Peabody Energy Corporation, American Gas Association, and ChevronTexaco (Brulle and Werthman 2021).

Both oil and gas and meat and dairy companies claim that technological developments and public awareness of these developments will extend their social license to operate. At a 2023 conference, the CEO of Occidental Petroleum told the audience that carbon capture technology "gives our industry a license to continue to operate for the 60, 70, 80 years…" (Lefebvre 2023). The former executive vice president of the American Hereford Association similarly claimed that AHA's "strategic partnership" work with AgNext on cow genetics as they relate to methane emissions "is going to help us maintain the license to operate" (Ishmael 2022).

Regulatory capture occurs when agencies become dominated by the special interests of the industries that they regulate over the public interest. Similarly, the corporate capture of academic institutions can occur when universities allow industry groups to use them to advance their own financial interests—often quietly and without the knowledge of the general public—by influencing research agendas and outputs, public messaging, and public policy recommendations in their favor. This analysis shows that, in exchange for donations, some universities have allowed the animal agriculture industry to support the work of professors and create new centers, which have in turn used the universities' credibility and appearance of academic independence to shape climate understanding and policy. Given the stakes of failing to mitigate emissions from animal agriculture, we cannot ignore the meat and dairy industry's use of universities in climate obstruction.

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Data availability All data analyzed during this study are included in this published article and its supplementary information files.

Declarations

Ethics approval and consent to participate This research did not involve human participants, or other animals.

Consent for publication Both authors (VM and JJ) consent to publication.

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