

Mitigating enteric methane emissions: an analysis of emerging media frames and consumer narrative tensions on natural solutions and techno-fixes

Article

Published Version

Creative Commons: Attribution 4.0 (CC-BY)

Open Access

Manning, L. ORCID: <https://orcid.org/0000-0002-9900-7303>, Wylie, A. ORCID: <https://orcid.org/0000-0002-4200-526X> and Goodman, M. K. ORCID: <https://orcid.org/0000-0003-4861-029X> (2025) Mitigating enteric methane emissions: an analysis of emerging media frames and consumer narrative tensions on natural solutions and techno-fixes. *Sustainability*, 17 (10). 4406. ISSN 2071-1050 doi: 10.3390/su17104406 Available at <https://centaur.reading.ac.uk/122781/>

It is advisable to refer to the publisher's version if you intend to cite from the work. See [Guidance on citing](#).

To link to this article DOI: <http://dx.doi.org/10.3390/su17104406>

Publisher: MPDI

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in

the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Perspective

Mitigating Enteric Methane Emissions: An Analysis of Emerging Media Frames and Consumer Narrative Tensions on Natural Solutions and Techno-Fixes

Louise Manning ^{1,*} , Adele Wylie ²  and Michael K. Goodman ³¹ The Lincoln Institute for Agri-Food Technology, University of Lincoln, Lincoln LN2 2LG, UK² Department of Real Estate and Planning, Henley Business School, University of Reading, Reading RG6 6AB, UK; a.wylie@pgr.reading.ac.uk³ Department of Geography and Environmental Science, University of Reading, Reading RG6 6AB, UK; m.k.goodman@reading.ac.uk

* Correspondence: lmanning@lincoln.ac.uk

Abstract: Reducing enteric methane production from ruminant livestock has been positioned as a key intervention to reduce global greenhouse gas emissions. Bovaer®, a feed additive purported to reduce enteric methane emissions in dairy cows by nearly a third, has received regulatory authorization in many countries. However, there is a dearth of evidence on the consumer's response to the use of such products. In the three weeks after 27 November 2024, there was a significant increase in media communications associated with the use of Bovaer® in Europe, and especially the United Kingdom (UK). This structured review of academic and gray literature and an iterative non-systematic survey of media discourse online explored and characterized the narratives that emerged in this three-week period of intense activity in both social media and mainstream media communications in order to critique the narratives and grammars within the public response and the implications for policymakers, industry and academia. The main narrative that emerged reflected the science-consumer tensions associated with the use of Bovaer® and the four sub-narratives shaping it (mainstream media influence and narrative framing, distrust in science and lack of relatability, conspiracy theories and fear-based narratives, consumer boycotts and market responses). Organizations adopting technological solutions to address 'wicked' societal problems need to understand the factors that trigger, amplify and attenuate social concern as expressed in mainstream and social media and need to adopt appropriate communication and dissemination activities to reduce the circulation of mis-dis-mal-information and promote information that is appropriate for multiple audiences and levels of understanding.

Keywords: methane; greenhouse gas emissions; enteric emissions; ruminants; reduction; Bovaer; narratives; media



Academic Editor: Mohammad Aslam Khan Khalil

Received: 26 February 2025

Revised: 6 April 2025

Accepted: 7 May 2025

Published: 13 May 2025

Citation: Manning, L.; Wylie, A.; Goodman, M.K. Mitigating Enteric Methane Emissions: An Analysis of Emerging Media Frames and Consumer Narrative Tensions on Natural Solutions and Techno-Fixes. *Sustainability* **2025**, *17*, 4406. <https://doi.org/10.3390/su17104406>

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The adoption of the 2021 Global Methane Pledge (<https://www.globalmethanepledge.org>) (accessed 23 February 2025) has led to a supranational commitment of more than one hundred and fifty countries to reduce global methane (CH₄) emissions by at least 30% of 2020 levels by 2030 [1]. Enteric CH₄ emissions reduction from ruminant livestock (cows, sheep and goats) is positioned as a key intervention to reduce anthropogenic-related greenhouse gas (GHG) emissions associated with food production. Due to microbial activity in the rumen when carbohydrates are broken down, ruminants emit enteric CH₄ as part of

the digestive process [2]. Enteric CH₄ comprises 17% of global CH₄ emissions and 3.3% of total GHG emissions [3]. However, digestive physiology varies between different ruminant species and breeds in terms of digestibility of feed, digestion processes and fermentation characteristics, retention time of digesta and associated enteric CH₄ emissions. While some dietary CH₄ mitigation strategies were effective for dairy cattle and, to a lesser extent, for beef cattle, they had minor or no effects in sheep; however, mitigation strategies to influence methanogenesis-related fermentation pathways were effective across all ruminant types [4].

Use of selective breeding and commercial feed additives to reduce enteric CH₄ production has been the subject of intense academic research. Higher feed efficiency, better nutrient utilization and feed management, and genetic improvement through selecting cattle, including dairy cows, for lower methane emissions-related traits [2,3,5] and feed additives, especially cattle rumen modifiers [3], have all been considered as potential mitigation options of interest. While the aim of this research is not to critique the scientific attributes of feed supplements for cattle per se, it is important to position that extensive research has been undertaken to develop such supplements whereby their intended mode of action is

“direct inhibition of methanogens or methanogenesis, suppression of ciliate protozoa, or providing or stimulating a competitive pathway for [hydrogen] H₂ disposal”. ([3], p. 3245)

However, the impacts of such direct interventions are scientifically complex; the enteric CH₄ emissions reduction benefits realized from applying a range of interventions may not be additive and also may differ in vitro compared with in vivo [3]. This influences the degree of the explainability of their use to a non-scientific consumer base. Other agricultural practice interventions, such as improving the health and welfare of ruminant livestock, conception rates and reproductive traits and genetic selection for increased milk yields at lower feed requirements, will have indirect benefits too, in improving net enteric CH₄ emissions [3], and also improving productivity and economic profitability [2,3]. However, where that beneficial economic return will be actually realized, either being retained on the farm, absorbed within the supply chain and/or alternatively proving a benefit for the consumer in terms of the price of meat and dairy products on retail shelves or in restaurants, is open to debate.

While the production of CO₂ comprises between 45 and 75% of rumen emissions compared with enteric CH₄ emissions of 20–30%, the global warming potential over 100 years (GWP100) of CH₄ is calculated as being twenty-five times higher than CO₂ even though it is much shorter lived in the atmosphere [6]. Thus, the focus on reducing enteric CH₄ emissions has gained both industry and wider policy interest. In summary, reducing enteric CH₄ and nitrous oxide (N₂O) emissions, i.e., non-carbon dioxide (CO₂) rather than CO₂ emissions themselves within ruminant production, is receiving much attention because they are deemed less expensive to mitigate than other GHG emissions-related options [3]. While algal-derived additives, tannins, saponins and essential oils have all been suggested as potential feed supplement options [7], one candidate intervention of interest is the use of 3-nitrooxypropanol, which has been studied for over 20 years in terms of its abilities as a feed additive to reduce enteric CH₄ emissions in ruminants (see [3,8]). However, 3-nitrooxypropanol, a component of Bovaer®, was found in a meta-analysis of extant studies to be more effective in dairy cows than beef cattle [8].

Analysis using Google Trends (<https://trends.google.com>) (accessed on 5 January 2025) reveals that internet searches for the term 3-nitrooxypropanol, or the trade name of a related feed additive product Bovaer®, had been minimal globally, despite its established approval and use in many countries. However, there was a considerable uplift in web search activity from 26 November to 10 December 2024, with individuals searching

for information on 3-nitrooxypropanol, and from 26 November to the end of December 2024 searching for Bovaer®, peaking on 3 December 2024. The catalyst for the attention, i.e. the trigger, was a press release published on 26 November by Arla Foods entitled “Major retailers join forces with UK dairy farmers to trial methane-reducing feed additives” (<https://news.arlafoods.co.uk/news/major-retailers-join-forces-with-uk-dairy-farmers-to-trial-methane-reducing-feed-additives>) (accessed on 5 January 2025). The narratives that emerged on social media were sudden and intense and exploring this process of events and the nature of the often conflicting narratives is the subject of this paper. The aim of this study is not to critique the use of Bovaer®, but instead to reflect on the emergent narratives within the wider discourse and the implications for the food industry seeking to adopt technological options, sometimes referred to as techno-fixes, to reduce GHG emissions associated with food production to deliver policy initiatives such as achieving net zero GHG emissions. Indeed, this situation informed two research questions that this iterative research explores:

1. What were the sudden emergent narratives that emerged with regard to the use of Bovaer® to mitigate enteric CH₄ emissions?
2. Is the discourse around interventions to mitigate enteric CH₄ emissions itself a barrier to understanding and acceptance by the general public, especially food consumers?

The paper is structured as follows: Section 1, the introduction, is built on in Section 2, which explores the narratives and contested spaces in discourse on agri-food transition. Section 3 critiques literature on the narratives of Big Food and the Biopolitics of enteric CH₄ emissions reduction in a wider discourse of GHG emissions reduction. Section 4 outlines the methodology, Section 5 explores the narratives that emerged and the implications, while Section 6 concludes the paper and reflects on the specific research themes that emerged that are of interest for further empirical research.

2. Narratives and Contested Spaces in Discourse on Agri-Food Transition

Past promissory narrative framing of ‘the silver bullet’ outcome of the use of genetically modified organisms (GMOs) in agri-food production led to the acceptance of GMOs in some countries and social backlash in others, especially in Europe, when the ‘technological fix’ was considered by consumers within the wider context of the politico-socio-technical food system [9,10]. Silver bullet promissory narratives are not new. These narratives have, for example, been linked to alternative proteins and cultured meat [11]. Decision-makers can favor sustainability-related silver bullet ‘techno-fix’ narratives because:

“it proposes simplistic, politically expedient solutions that often postpone the need for an effective response to complex, often wicked, problems beyond their scope of responsibility and oversight”. ([10], p. 8), see [12]

Post-Paris emissions-related narratives around emissions reduction/removal technologies [13] argue that the narratives are not positioning silver bullet solutions to ‘fix’ the climate problem, but they sit instead within a politicized terrain of agri-food system reconfiguration. With this, the narratives are ‘Trojan horses’ that offer opportunities for providing a response to the challenges of a changing climate but often with timeframes for realizing outcomes well into the future, allowing a delay in adopting other less geopolitically and socially unacceptable, but effective decarbonization efforts today. The ‘Trojan horse’ narrative has also been used to describe how the techno-fix provided by commercial private parties for governments can cause a form of dependency, shifting power (sovereignty) from the government to the private organization proffering the solution [14]. In this context, climate-related narratives are more about the desired framing and articulation of the transition and the role of specific actors (in this case, farmers, processors, retailers,

government, non-governmental organizations (NGOs) and so on) rather than exploring the consequences of inactivity, i.e., translating matters of fact, which may be difficult for many audiences to understand into matters of concern [13,15].

Ref. [16] (p. 29) uses the word “atmosfear” to describe the “discursive practice used to accelerate the implementation of greenhouse mitigation policies”. Indeed, they argue, atmosfear uses signifiers (signals) of peril, ‘Armageddon’, and/or crisis in order to drive behavior change. Creating “atmosfear” requires the development of a narrative relationship between the victims of climate-related disasters and often unconnected “harmful activities”, both individual and collective, that need to be addressed to relieve the experience of those impacted. In short, the development of an atmosfear sets “a moral liability to establish climate policies and to undertake actions that can reverse unacceptable practices” where specific actors define what is unacceptable ([17] p. 78). Thus, methane emissions and the need to reduce them have been narratively linked to reducing climate risk [18]. Ref. [15] (p. 2) argues that:

“risk governance is invariably shaped by the way climate risks are defined, and it manifests itself in the ways we talk about climate. By focusing on technical, quantifiable definitions of risk as the probability of defined losses, this privileges scientific and professional knowledge systems and excludes other citizens from the discussion, reducing them to ‘subjects to educate’. But in daily life and actual practice, the physical climate and the social climate, the material and the semiotic nature of climate are inseparably intertwined”.

A further factor is that these narratives often have associated meanings or moral positioning about what is ‘good or bad’ [15]. Good farmer/ bad farmer narratives (see [10]) have been linked to new technologies or practices such as cultured meat [11], animal welfare [19,20], bovine tuberculosis policy [21] and regenerative agriculture [22], especially their economic viability [23] and wider perceptions [24]. Ref. ([25] p. 5) states that

“social actors working in private and public contexts to shape these [technology] innovations hold a narrow set of values about [what it is to be a] good farmer, farming and good technology and their data practices privilege large- scale and commodity crop farmers. . . . [and] suggest the need for an responsible research and innovation rubric to guide the digital agricultural transition, ensuring that innovations are designed to deliver benefits such as improved productivity and/or eco-efficiency that can be widely shared”.

Farmers can be agents of change by deploying interventions, but the processes adopted are often prescriptive, hindering the farmers’ collaborative interaction and their ability to retain the economic and social value of transitioning [10,26]. In the context of enteric CH₄ reduction, [1] describes the narrative of “good cattle for a good Anthropocene”, as “metabolo-politics”, a form of capitalist bio-power that focuses on the technofixes that influence the metabolism of ruminants and their use for a ‘good’ world. While the utilization of the good farming, good farmer, good animal and good technology discourse in public narratives has been analyzed, others argue that transition narratives need to embrace cultural, social and localized place-based aspects and expectations even if there are more global counter-narratives that are ‘louder’ and embrace conventional, accepted thinking [22,27,28]. The biopolitics associated with food had been explored in a number of previous papers [29–31].

Exploration of animal welfare discourse informed the characterization of five distinct narratives: the ‘animal rights/human power-based’ narrative, the ‘farming as a business’ narrative, the ‘lower versus higher welfare’ narrative, the ‘religion-based’ moral narrative, and the ‘research, legislative and political based narrative’ [19]. Neoliberal capitalism, for

example, has a dominant narrative of “free enterprise, growth, globalization, individualism, competition, free choice, privatization and reduced governmental roles or social welfare benefits” [27] (p. 19). This narrative [27] raises questions of ‘productivity gains, innovation and profits for whom, to what ends and at what costs?’ Others have argued that these narratives must provide for understanding when considering complex issues, and they can be a means of empowering the ‘silent voices’ of the marginalized, localized or powerless [15]. Ref. [13] explores several climate-related narratives, building on the work of [32,33]:

- *Civic environmentalist narrative* that focuses on a bottom-up approach to achieving environmental objectives, i.e., the solutions are place-based, culturally and socially acceptable, and embed climate justice for the communities impacted;
- *Climate imperative narrative* that emissions reduction interventions are necessary, certain, even mandatory to achieve environmental objectives;
- *Eco-modernist narrative* that promotes cost-effective climate change mitigation via an interventionist “win-win approach” that uses techno-fixes and market-based solutions, albeit that not all actors will derive equal value or benefit. This eco-modernist narrative is explored by [1] in the context of enteric CH₄ emissions and the role of the eco-technocapitalist;
- *Green governance narrative* that centers on delivering environmental objectives through professionalized, directive resource management, environmental goal and target setting and monitoring, e.g., the global supranational operationalization approach of the Sustainable Development Goals (<https://sdgs.un.org>) (accessed on 5 January 2025);
- *Natural solution vs. techno-fix narrative* that positions that while there are potential techno-fixes that can deliver environmental objectives, they may have negative externalities, e.g., impacting on animal welfare, worker wellbeing or consumer health, while natural solutions may have less positive externalities, but they will deliver fewer negative externalities, e.g., selective breeding more holistic integration of a range of environmental objectives (co-addressing impacts on air, soil and water) and as a result incrementally changing to farm practices to reduce enteric methane production (what might be described as a more regenerative approach) rather than applying a techno-fix to one aspect which could have other sustainability aspects. Nature-based solutions are being proposed in many sustainability remediation processes, especially water management and biodiversity recovery, rather than ‘hard,’ more physical and more technical interventions.

However, Ref. [13] infers these narratives are not discrete, and there can be crossover and overlap within contemporary discourse. In their research with farmers’ perceptions of how cultured meat could cause elements of the food system to transition three similarly characterized narratives emerged: the ‘environment-based’ narrative, the ‘socio-economic narrative and the ‘ethics and affective narrative’ [11]. These three narratives map across many of the previously characterized narratives, but a central theme in [11] is consolidation and utilization of power, the processes of corporate lock-in, inequality within a transitioning agri-food system, including land-grabbing, and a policy focus on short-term delivery via techno-fixes rather than longer-term natural solutions [34]. Analyzing media sources [35] suggested three prominent ‘grammars’ associated with cultured meat—cultured meat as a ‘solutionist’ technofix, cultured meat as a ‘virtuous’ technology given its environmental and food security possibilities, i.e., low carbon intensity food is ‘good food’, and cultured meat being ‘in tension’ with the farming sector as well as consumers’ health and taste buds. Eco-technocapitalism is an emergent term in the literature [1]. Technocapitalism has been defined as the commodification of knowledge via technological use with a central focus on the corporatization of ideas, invention and continuous innovation and rapid adjustment, e.g., biotechnology, bioinformatics, robotics and nanotechnology [36,37], and more

latterly agri-food-related technology. The ‘black-box’ opacity of complex technocapitalism approaches, combined with the rapid implementation of the technologies, means that the specific operational activities and their technological and hierarchical deployment can accelerate beyond citizen perception of their adoption and articulation of any concerns and citizen understanding of their meaning [38]. More generally in the literature, the neoliberal narrative has centered on the concept of power consolidation during sustainability transition associated with the conceptualization of “Big Food”, in its own distinct narrative, and this is discussed in the next section.

3. “Big Food” Narrative

The “Big Food” narrative posits that the largest, often transnational, food and beverage manufacturers and corporations, while providing most of the food in the world, also control the food system, especially food policy, through the enacting of their role and how they frame financial and non-financial value and food-related values in the wider context of the triple bottom line of sustainability (profit, planet and people). Ref. [30] defines this as the biopolitics of food [39]. Big food companies have been linked with providing ultra-processed foods and lobbying to influence policy [35,40], often shaping the regulatory environment(s) in which they operate and creating a form of legitimacy through their ability to functionalize food to provide solutions to policy ‘problems’ within public-private partnerships, often at a supra-national level [39]. One study argued that global North-based corporations when operationalizing in developing economies, lobbied their own governments to “influence international issues; made political contributions; participated in a ‘revolving door’ between government and industry; funded professional organizations; and generally lobbied to resist regulation or urge weak regulation” [41] (p. 455). Big food organizations have also been positioned as seeking to influence global institutions and their policies through three key strategies: coalition management (creating and utilizing a coalition of public and private actors), influencing policy formation and revision (through lobbying and formal consultations), and information management through funding and engaging with communication channels [42,43].

With a specific focus on improving efficiency and reducing the environmental impact of cattle production (beef and dairy), narratives reflecting anatomo-politics and the anthropogenic interventions that influence fertility, microbiome and productivity, sees biopower enacted through forms of governmentality, i.e. regulations, rules, benefits and sanctions [44]. In the context of this study, a form of green governmentality and the counter/contributory market approach of eco-techno-capitalism emerge via mechanisms of disassembly (unmaking) and reassembly (making differently), where cattle-related methane is reframed as a food system issue rather than an overconsumption issue [44]. New technologies are “often accompanied by hopes that they will solve societal or ‘grand’ challenges through pathways of commercialisation that also contribute to economic development and productivity” [45]. Ref. [1] (p. 274) summarized this in the context of methane-reducing feed supplements:

“Interventions are centered on bovine metabolisms at different spatial and temporal scales; they include the use of feed supplements that inhibit methane production in bovine rumens during digestion, and selective breeding or genetic engineering for the breeding of future-ready low-methane cows. In these bovine “technofix” solutions, the global scale is invoked to drive metabolic interventions at multiple smaller scales including individual cows, their microbiomes, and their genomes. Research, however, suggests that these interventions do not neatly scale back up as invoked by those deploying them for climate-related ends. Rather, the global scale functions discursively to incentivize bovine metabolic intervention,

influence agricultural policies, and draw investment into ecomodernist visions of “good cows for a good Anthropocene”.

The power of corporate food actors should not be underplayed nor dismissed, and neither should the power of media narratives and discourses or online influencers to guide, dictate and shape societal perceptions of food and food systems, which, at this moment, can often travel quite comfortably into the conspiratorial. Indeed, in research looking at online farmers’ responses to cultured meat, [35] found that many discussions leaned into conspiratorial thinking with the suggestion that the facilitation of the technology and markets for cultured meat was perpetrated by the likes of Bill Gates and other billionaires to remove livestock farmers and grab their land for, for example, the purposes of rewilding. Powerful social media platforms, the growing ‘death’ of expertise, rapid food-focused technological changes, and the increasing consolidation of power in food systems to fewer and fewer powerful corporations has meant that what some might describe as new biopolitical and eco-technocapitalist ‘devices’, such as Bovaer©, are given not only more scrutiny and discussion from the public and consumers than in the past, but also that these products are fuel and fodder for the conspiratorial imaginations of those inhabiting digital foodscapes.

4. Methodology

This research uses a grounded foundational literature review followed by a series of iterative searches to theoretically frame the findings that have been derived from a thematic analysis of secondary data (media sources) rather than through the deductive forcing of pre-existing theories. The iterative searches led to a group of search terms (Table 1) that were then used in multiple keyword search combinations in Science Direct, Google Scholar and Google (to include gray literature as emergent narratives are represented here) until data saturation was reached [46]. The sources identified in the searches ($n = 80$) were then considered for relevancy, and any duplicates were eliminated. The papers were screened, and if appropriate, read in full and data was extracted that has supported the narrative and argument of the paper. To ground the conceptual research and to inform the findings the authors limited their collection and engagement with gray literature given that, while it has value in the triangulation of evidence, it may not be academically robust in terms of representativeness or generalizability [10]. Overall, 88 sources from the iterative review were used to support the analysis and arguments of this paper.

Table 1. Search terms used to develop the iterative review.

Level 1	Level 2	Level 3
Methane emissions OR Enteric methane emissions	Cattle Narratives Reduction technologies	Post-Paris Silver bullet
Bovaer	Marketing strategy	

The geographical focus of the sources extracted is predominantly the Global North, and the focus of this paper is the UK context, again influencing and narrowing generalizability of findings. The methodological approach taken to synthesize the literature has been holistically flexible and reflexive rather than following a more highly structured and overtly systematic approach to data collection and analysis [26].

To capture the social media and mainstream media landscape concerned with the use of Bovaer© in the UK, in the three weeks after 27 November 2024, a non-systematic survey of media discourse online was completed. The three-week period was chosen because

this was the timescale of the increased interest in Bovaer® before it dissipated within the media. The aim was to find out which stakeholders (newspapers, supermarkets, non-governmental organizations (NGOs), the public and farmers) were informing consumer responses, and what these responses were, and what narratives/discourses were being constructed. Our methodological approach, which encompassed qualitative media data collection, entailed identifying the social and mainstream outlets most likely to be accessed by the general public and be host to the spaces where the narratives around Bovaer® were being constructed. In turn, we developed a list of the following social media platforms: Facebook, Instagram, X (formerly known as Twitter) and TikTok. The mainstream United Kingdom (UK) media outlets were: The Guardian, The Mail, The Financial Times, The Express, The Sun, The Metro, Sky News. We also searched the social media profiles and websites of the following UK supermarkets: Sainsbury, Aldi, Lidl, Morrisons, and Tesco. The search terms applied to these searches were “Bovaer”, “Arla”, and “Lurpak”. These search terms were used to provide a comprehensive sample of posts and narratives directly about Bovaer®. We included the search terms “Arla” and “Lurpak” to capture adjacent—but relevant—posts and discourses related to Bovaer®. The food multinational Arla could potentially use milk from cows given Bovaer® for its well-known butter spread Lurpak. As we show below, both Arla and Lurpak became important foci for posts and media narratives about Bovaer®.

To identify key themes and patterns within the qualitative media data, we looked for recurring words, images, narratives, phrases and hashtags being used throughout the social media posts, within the comments sections, or within newspaper articles and titles of the articles. The newspaper articles, social media posts, comments sections and images were analyzed qualitatively to understand the discourses that were being produced and by whom. Within the text, we analyzed the word choices, especially in any titles, hashtags, or images used. We also analyzed the tone of the “voices” in the text to explore whether they were opposed or supportive of Bovaer®. With the work of [35] in mind, we looked for tones that might have been feeding into existing narratives seen around cultured meat that were conspiratorial in nature, as this in turn could be an indication of the construction of new or supporting of existing discourses reliant on and/or built upon fearmongering and the spread of mis/disinformation surrounding net zero policies/carbon politics. Thus, our qualitative analysis was based on grounded theory [47], bringing together content analysis techniques [48], and linguistic narrative and discourse analysis [49]. This approach allowed us to understand and analyze who were the loudest voices in communicating about Bovaer® to consumers as well as those who were loudest in the consumer responses themselves. Attention to the loudest voices allowed us to determine who was shaping the narratives and discourses around Bovaer®. Similarly, we considered which stakeholders’ voices were silent/absent (in this case food retailers/supermarkets) from these discussions and what the motivations for this could be. In the analysis we also looked for similarities and differences within and across social media platforms and media outlets. Overall, through the analysis, we found that tensions exist between science and consumers regarding carbon reduction technologies and these tensions were constructed through various narratives. In the section that follows, we discuss these findings and analyze the narratives.

5. Science-Consumer Tensions Around Bovaer® and the Sub-Narratives Shaping It

On 26 November 2024, Arla Foods published a press release that included the following text:

“British farmers that make up the UK’s biggest dairy cooperative, Arla, have joined forces with some of the biggest retailers in the country to tackle methane

emissions. In a first of its kind joint initiative, the project will see a collective effort across the food industry to trial the use of Bovaer[®], a feed additive that reduces enteric methane emissions from cows on average, by 27%. As part of its FarmAhead[™] Customer Partnership initiative, Arla will work alongside retail partners Morrisons and Aldi, and with Tesco on its new Future Dairy Partnership initiative, to highlight how feed additives can be introduced to normal feeding routines. The new project which will also involve around 30 of Arla's farmer owners, aims to provide a better understanding of how these feed additives can be rolled out across a larger group of farmers. . . . Arla's Bovaer[®] trial will provide a more practical understanding of how to scale the use of feed additives, how it impacts on farm operations and the opportunity to work more collaboratively with the feed industry. . . . As part of its ongoing commitment to reducing the impact of dairy production, Arla has ambitious science-based targets, including reducing CO₂e emissions from scope 3 by 30% by 2030".

This press release proved a trigger to a range of narratives emerging in the UK mediascape. In previous work on food 'scandal' narratives in the media [50], there are a series of steps that occur; firstly, shock arising from the event (in this case, the publishing of the press release); and then the incident amplification phase, where media engagement increases via a cascade effect until the 'scandal' narrative itself gains its own entropy fueled by socio-political amplification factors and this leads to either single or multiple 'explanatory' discourses emerging within the media.

Sensemaking is the process of seeking to understand novel, confusing or ambiguous events [51–53], and develops via a collective, co-constituted narrative process via three processes scanning, interpreting and responding [54]. Our findings, which are now presented, have arisen out of this need for sensemaking and also the mediated process of sense giving, where events are framed via discursively negotiated socio-political lenses and a need to legitimize [55]. Sensemaking within the sphere of social media is a collective activity driven by individuals who firstly seek to gain missing information from others to influence their behaviors and potential outcomes (economic) and to cognitively understand the situation (psychological) in a form of social alignment [56]. Thus, these narratives, formed by actors who are starters, transmitters, and/or amplifiers, encompass seeking, negotiating and sharing of information, reactions to that information, seeking to understand the 'why,' sharing opinions, questioning outcomes, seeking solidarity and creating a 'talking cure' [57]. Our qualitative discursive analysis of the UK mediascape, encompassing both social and mainstream media discussions on Bovaer[®] use in the UK, revealed a predominant theme: tensions existing between science and consumers regarding carbon reduction technologies. These tensions are constructed through interconnected sub-narratives, including media framing, distrust in science, conspiracy theories, and consumer responses. This section explores these themes in detail and compares and contrasts them to previous work on the UK mediascape of cultured meat [35].

5.1. Mainstream Media Influence and Narrative Framing

Mainstream media outlets varied in their framing of Bovaer[®]. Sources like Sky News, BBC, and The Guardian adopted neutral and descriptive tones. Headlines included "dairy products being boycotted over controversial additive" (BBC), "shoppers have threatened to boycott three major supermarkets over their participation in a new trial to add methane-suppressing supplement into cow feed" (Sky News) and "dairy products being boycotted over controversial additive" (The Metro). Although the Sky News headlines were more descriptive than provocative, many people responded on Twitter/X to highlight that the boycott was not a threat as they had implied in their headline, that they were in fact

already not buying the products and they had sourced alternatives. On Twitter/X someone responded “I have already done it and made alternative arrangements. I think many people will do the same”. Another said, “already ditched them! I get my organic, fresh, non-poisoned milk locally. No toxic, experimental dairy for me”. Someone mentioned, “it is not a threat, it’s a movement away from dangerous BS that has no place in the food supply”. Others asked for transparency: “it should be labelled on the products which have Bovaer[®] in it”, “I want to know which milk products have this added”. The Daily Mail took a starkly different approach, releasing multiple articles using alarmist language in the titles, such as “contaminated”, “toxic”, “cause cancer”, “the “re-engineering of the cow”, “eco-war”, and “epic battle”. As we will show in the sections that follow, this framing intensified consumer skepticism, and in turn there were many responses from the public on social media that constructed narratives of a distrust in science, fear, and conspiratorial sentiments around Bovaer[®] mirroring the discourses found by [35].

On Instagram, narratives diverged, with some consumers emphasizing animal welfare over consumer safety. To illustrate, responses to a BBC post on Instagram titled “have you been seeing people pouring milk down their drains on your socials?”, where the BBC then posted a link to their article, differ significantly from the comments seen on Twitter/X and Facebook. On this platform, those who don’t consume dairy products have more of a voice and show a resistance to Bovaer[®] as a technofix, again aligning with narratives associated with cultured meat [35]. These perspectives are limited; however, they show concern for the animals in this trial rather than only coming from an anthropocentric perspective: “how about we stop finding new ways to continue enslaving, exploiting, commodifying, torturing, and killing animals who are sentient like us”, and “here is an idea: stop drinking milk! You’re not an infant, and you’re not a cow”. There was also judgment for the fact that people are wasting food products: “making a video of yourself throwing away food is the most first-world thing I have ever seen” and “wasting food because *checks notes* getting rid of cow burps and farts is bad?????????”. These perspectives contrasted with Twitter/X and Facebook, where concerns about food safety and transparency dominated.

5.2. Distrust in Science and Lack of Relatability

The most dominant narrative seen in consumer responses to Bovaer[®] is distrust in the government and science, which is intertwined with concerns of a lack of transparency and concerns of safety (i.e., perceptions of consuming milk that is somehow unsafe due to Bovaer[®]). This distrust stems from a lack of relatability with science more generally [58] and is not limited to this context. Distrust in ‘the science’ is embedded in the climate change discourse in general and can be seen in many discourses surrounding climate change and emerging carbon reduction technologies (see, for example, the work of [59,60]). Some consumers on social media question whether the scientists who are referred to as experts in the media are paid to deem products safe: “they (the BBC) cited experts but wouldn’t say which experts and paid by whom”, said one Facebook user. The distrust of science was captured from the comments section of a Daily Mail online article posted on Twitter/X titled “Expert’s verdict on Arla Foods’ ‘Bovaer[®]’ following alarming claims that milk from Tesco, Morrisons and Aldi is packed with cancer-causing additive”. One person responds with an image of a scientist looking through a microscope at a large roll of dollars, which is captioned “97% of scientists agree with whoever is funding them”. Someone responds with a cynical tone that “this will be the same scientist who told us the COVID-19 (vaccine) was completely safe”. Someone else responds to the image and indicates that science is not being communicated effectively: “I find it hard to trust any “expert” anymore; they all repeat the data in different ways”. Another person responds by questioning the intelligence of those who trust mainstream media: “if you are retarded enough to fall for

a mainstream media thread that starts with “expert’s verdict” you probably deserve all your gonna get”. One argues that customers are becoming passive subjects “nobody cares that they experimented on customers without approval”. Similarly, an image shared in the comments section read, “BOYCOTT Bovaer[®] milk trial with Morrisons Aldi & Tesco. . . I’m not your Guinea-Pig”. Lastly, someone posted a single word in inverted commas: “experts”.

The perceived complexity and inaccessibility of scientific discourse fuel skepticism and fear and this seems to intensify when scientists or food producers use technical language, which can alienate consumers. Arla, for example, used the word ‘trial’ when introducing Bovaer[®] in the press release and this may have given the impression that UK consumers were being used as “guinea pigs” to test this new additive, yet those posting may or may not know that Bovaer[®] was already commercially available in over 60 countries. The narrative constructed around the idea of Bovaer[®] as a trial/scientific experiment was prevalent in the comment sections on Facebook and TikTok, with consumers voicing concerns that Arla “use the public as lab rats” (Facebook) and that “it has not been tested fully, the long-term effects is the concerning thing” (TikTok).

Many felt that the government cannot be trusted as they permit companies, such as Arla to test products on consumers: “The safety is irrelevant [sic]. Bovaer is a WEF netzero scam. Someone owns the license and distribution rights and will make billions via WEF governments who have been told to make it mandatory” (TikTok). “Bovaer, dangerous if inhaled and a skin irritant, yet alright to give cows and assured by Government food standards that it won’t effect the milk we drink! Yeh; right!!!!” (Facebook). “It seems it is much bigger than a trial. There is a Bovaer plant being built in Scotland due to be finished next year. [. . .] Oh, and the company manufacturing Bovaer also manufactures a fake meat product and its CEO is WEF (world economic forum) affiliated” (Facebook). “Do not look on Government websites, that is the first mistake if you are looking for the truth” (Tik Tok). These examples potentially highlight the distrust in the science and those communicating about the science and the lack of relatability.

Ref. [61] considers how relatability influences societal perceptions of the credibility of science-related communications, i.e., that relatable science is communicated and summarized at a scale and depth that is compatible with stakeholders’ understanding, or lack of understanding of a topic. For science to be relatable, it must be person-centric, recognizing the knowledge and information gaps of stakeholders and the opportunities for inaccurate information being shared by others and how its influence can be minimized. Inaccurate information about individuals, organizations and governments can be differentiated as misinformation or disinformation [62]. Organizations seeking to correct misinformation or inadvertently sharing of information, which is inaccurate or can be misconstrued, need to consider that a formal retraction ‘to set the record straight’ may fail or, even worse, backfire, since reinforcing instances of misinformation may increase the general public’s familiarity with the inaccuracy or omission and, as a result, strengthen false belief. Disinformation, or fake news, is the intentional creation or sharing of false information with the aim to mislead or lie. Consumer studies have highlighted that the impact of fake news is brand specific, i.e., while in some instances, the spread of fake news has a negative impact on consumers’ trust in food organizations, in other cases the impact has been minimal or even positive, depending on the brand owners’ reaction and routes of redress [63,64]. For fake news to be effective, it must seem plausible, have a high level of entropy and velocity and also be impactful [65]. Consumer trust in food safety and the influence of fake news have been studied in China and Malaysia [66,67]. Technologies such as artificial intelligence are being proposed to counteract fake news and mis-dis-mal-information and support effective fact-checking [68], and fake news detection [69–71], particularly with food safety [67].

Malinformation is “information, that is based on reality, but used to inflict harm on a person, organization or country” [72] (p. 44). Digital malinformation is truthful information that is shared electronically through social/online media with the express intention to cause harm to individuals, communities or organizations [73]. Mis-dis-mal-information is not a new phenomenon [74,75] and can be used by specific actors (agents), using digital artefacts to discredit organizations or individuals (targets) and existing science-based evidence, and cause confusion, controversy, conspiracy theories, economic loss, reduced trust and polarization of viewpoints [73,76]. Mis-dis-mal-information during the COVID-19 pandemic was also shown to cause significant supply chain disruption with panic buying leading to empty shelves, imports and exports being affected and production resources [77]. When the public becomes confused with misinformation, often creating false beliefs, they can refuse to trust information that is genuine when it is presented [77]. This confusion can arise because of a lack of knowledge associated with the information, which influences interpretability at the individual and/or organizational levels or because the information has specifically been designed to be difficult to interpret [75].

5.3. Conspiracy Theories and Fear Based Narratives

In one post shared on Facebook information has been taken from the website of the company who own Bovaer© DSM—Firmenich who state that Bovaer© is naturally metabolized by the cow, is safe for the cow, and is not transferred into the milk or meat, therefore is no concern for the consumer. This is shared on Facebook alongside the text “LOL, I call bullshit [on] this latest Big Food poison”. Big Food, as a construct, has previously been critiqued in this paper and multiple comments under this post, question the behavior of people in blindly trusting corporations when they say something is safe. There is a comparison in the on-line narratives to the COVID-19 vaccination roll out: “they did safe and effective with covid vaccines, look how that turned out to be, complete lies”. Similarly, but under a different post, it was stated that “if they didn’t get us with the hashtag ConVid vaccine then this is the ultimate weapon”. In the hashtag they write “ConVid” rather than COVID to possibly emphasize the idea of being conned by those who produced COVID-19 vaccines.

As highlighted by [35], Bill Gates is a “frequent ‘bogeyman’ in conspiratorial narratives”, and many farmers were found to perceive him this way in the conspiratorial discourses surrounding cultured meat. We found this to be no different around the Bovaer© trial. His name frequently appeared across social media platforms in the construction of conspiratorial narratives. The responses show a lot of anger and distrust in techno-oligarchs and their perceived as well as actual roles in techno-fixes to reduce the anthropogenic climate impact of the food system. The conspiratorial narratives also worked towards framing Bovaer© and Arla products more generally in this three-week period as “bad food”. Similarly, mad cow disease, i.e., bovine spongiform encephalopathy (BSE), was referred to on numerous occasions as reinforcing negative perceptions of technological interventions in the food chain. An image of a truck full of dead cow carcasses being disinfected by people in protective clothing, with many more carcasses lying on the grass beside it was shared on Facebook; it was captioned “Mad Cow Disease (BSE), the last time people tried to change a cow’s diet”. These posts relate back to the BSE crisis that started nearly 40 years ago in the UK which was linked to new variant Creutzfeldt-Jakob disease in humans. These posts imply, despite regulatory approval of Bovaer© in multiple countries around the world, that Bovaer© presents a potential health hazard to humans. Furthermore, as science-led innovations such as cellular agriculture and cultured meat are framed as being in conflict with traditional natural methods [11,35] terms like “Frankenmeat”, “labour’s Franken milk”, and “Frankenstein” emerged within the social media in reference to Bovaer©, with some

people questioning the role of science in playing God and manipulating the natural order of things. To illustrate, multiple Facebook comments mention milk production as a “natural biological process” and that science should refrain from manipulating this: “we hope all farmers will resist this stupid intervention to stop cattle doing a normal body function, it is meddling with God’s work. Leave our cattle alone [Bill] Gates”. Such concerns about scientific intervention conflicting with “natural” processes or divine order contribute to consumer resistance, and this is seen in the boycott movement that targeted Arla products in this time period.

5.4. Consumer Boycotts (And Buycotts) and Market Responses

Given the fear, mistrust, and misinformation being constructed online through the narratives discussed so far, many consumers decided to boycott Arla products. Boycotting and buycotting foods have been seen as forms of political activism, with boycotting seen as an intentional act to punish a food company or to demonstrate distrust in governments or food organizations whereas, buycotting is an intentional act to purchase specific foods to drive change, e.g., purchasing plant-based or vegan foods [78]. The boycott movement in the case of Bovaer© grew in traction over social media where messages and images to boycott were shared on all social media platforms. People shared videos of themselves pouring Arla milk products down the sink, and this led to mainstream media covering the boycotting stories in their newspapers, providing an amplification effect that caused greater entropy within the narrative. In response, supermarkets that stock Arla products such as Aldi, Morrisons, and Tesco stayed relatively silent on the matter, their strategy appeared to be to “ride out the storm” as consumers tagged them in numerous posts regarding the Bovaer© trial and their intent to boycott their stores. Sainsbury responded to consumer questions on Twitter/X to assure them that their own brand products were Bovaer© free.

This differentiation in the media with the introduction of a narrative around there being ‘Bovaer©-free products’ further fueled and amplified the traffic on social media. Some organic farmers and small farm shops leveraged public distrust to position their products as “safer” alternatives. As they distanced themselves from the use of Bovaer©, they used language such as “you can trust us” and “safe”, which reinforced distrust in Arla products and validated the fears and distrust the consumers had. One farm shop reinforced the idea that the additive was interfering with the natural order of things: “Rest assured we don’t agree with feeding animals any feedstuff that is designed to chemically change their natural processes [...] not for us; not for our animals [...] cows are not the problem”. One farm even communicated that they had run out of milk due to what they called a significant rise in “people sourcing unadulterated milk after the Bovaer/Arla scandal”. One slogan that made it across social media platform and that was adopted by consumers, organic farmers and small farm shops was ‘full fart milk’: “Full fart milk only from now on! Only buying small and local” and “cows for emission equality—my fart: my choice”.

5.5. Summary

The tensions between science and consumers surrounding Bovaer© highlight the challenges of introducing carbon reduction technologies in food systems. On 3 December 2024, Arla produced a second statement that stated that due to a large volume of online misinformation, they felt they needed to address the content by stating a series of facts [79]. This statement outlined that research had taken place for the last 15 years and Bovaer© is being used in 25 countries for over 200,000 cows, while now being approved in 68 countries. Further, they reiterated that there was no evidence of harm to animals or humans. The current on-farm research is investigating the use of Bovaer© in different contexts (production systems and herd sizes) to determine its efficacy and economic impact [80]. Media framing

played a crucial role in shaping public perceptions, with neutral reporting failing to counteract the alarmist narratives propagated by other outlets. Consumer skepticism, fueled by distrust in science and conspiracy theories, underscores the need for greater transparency and accessible communication about technological solutions to address anthropogenic contributions to GHGs, including agri-food production. Finally, the boycott movement and market responses illustrate the power of consumer narratives in shaping food industry practices. Seeking to address misinformation and consumer concerns on 5 December 2024, the UK FSA issued a categorical statement: “Milk from cows given Bovaer®, a feed additive used to reduce methane emissions, is safe to drink. The additive is metabolized by the cows so does not pass into the milk”. The statement also reinforces the regulatory processes that have been undertaken to approve the product for use, and there was no cause for concern in the 58 studies they examined [81].

Addressing these tensions will require engagement with public concerns and building trust in the underpinning science and regulatory approval for climate-related innovation. The World Health Organization [82] describes this surge in information, both truthful and false or intentionally misleading as seen with COVID-19, as an infodemic, stating: “An infodemic is too much information, including false or misleading information in digital and physical environments during a disease outbreak [...]. It causes confusion and risk-taking behaviors [...]. An infodemic can intensify or lengthen outbreaks [...]. With growing digitization—expanding social media and internet use—information can spread more rapidly. It can help fill information voids more quickly and amplify harmful messages” [75] (p. 736). Business organizations faced with this media onslaught, especially in geopolitically sensitive, socio-economically turbulent and/or transitioning operating environments can experience significant impacts and disruption. Thus, effective preparedness strategies are required to build resilience to mis-dis-mal-information and knowledge gaps. Ref [83] argue that effective response mechanisms that address mis-dis-mal-information require: firstly governments and food organizations to strengthen their resilience interventions through effective analysis and monitoring of the impact of the surge in information via implementing systems that can detect the relevant digital and traditional media signals and determine their reach, to engage in social listening [84,85] and be prepared to disseminate trusted information through trusted platforms. Factors that can be considered in social listening include which topics are gaining entropy (traction) and the patterns in engagement with them, the top and rising search terms, hashtags and keywords, the type and content within online conversations, complaints (frustrations that are expressed) and questions (signs of confusion and lack of knowledge) [85]. Secondly, multisectoral collaboration is needed between academics, media and technology platforms to reduce mis-dis-mal-information, algorithmic and computational amplification of certain messages, activities of bots, and microtargeting of content so they are able to debunk claims and assertions and embed fact-checking [84].

6. Conclusions

The analysis of citizens and, more particularly, consumer acceptance of the use of Bovaer® in this research has been conducted at a relatively macro level through the framing of narratives in the media. This work provides context and further investigates the reported acceptance of Bovaer® among various consumer groups, including dairy product consumers, organic food consumers and non-dairy product consumers, and to compare and contrast acceptance levels between these groups. Methane reduction at the farm level is an explicit requirement if the Global Methane Pledge is going to be met. While some studies suggest that methane production can be reduced through the use of Bovaer by 30% [86], this research area is a fast-changing space. There are studies being published that

are identifying how different feed regimes and production systems are impacting positively (GHG reduction) and negatively (animal performance) [87] and the role of the breed of cattle/cows [88].

The aim of this study was not to critique the use of Bovaer® or other methane mitigation approaches in ruminant-based food production, but instead to reflect on the emergent narratives within the wider discourse when the recent trial was announced in the UK and the implications for the food industry seeking to adopt technological options to reduce GHG emissions associated with food production. This iterative research addressed two questions: What were the sudden emergent narratives that emerged with regard to the use of Bovaer® to mitigate enteric CH₄ emissions? And is the discourse around interventions to mitigate enteric CH₄ emissions itself a barrier to understanding and acceptance by the general public, especially food consumers? The narrative that emerged reflected the science-consumer tensions associated with the use of Bovaer® and the four sub-narratives shaping it (mainstream media influence and narrative framing, distrust in science and lack of relatability, conspiracy theories and fear-based narratives, consumer boycotts and market responses). These narratives clearly show the tensions between scientific transition within food supply chains and the barriers that can emerge to consumption of the food products that are derived. The responses varied from a request for information to fear-based responses and concerns over conspiracy theories and power dynamics within food supply chains. The research shows that organizations adopting technological solutions to address specific challenges, whether that is reducing GHG emissions, or other ‘wicked’ problems, need to understand the factors that trigger, amplify and attenuate social concern when new technologies emerge and are adopted at scale, as may be expressed in mainstream and social media. Furthermore, they need to adopt appropriate communication and dissemination activities to reduce the circulation of mis-dis-mal-information and promote information that is appropriate for multiple audiences and levels of understanding so that these transitions can be visible, transparent, inclusive and accepted by those communities that will ultimately consume the food.

Author Contributions: Conceptualization, all; methodology, all; formal analysis, A.W.; writing—original draft preparation, L.M.; writing—review and editing, all. All authors have read and agreed to the published version of the manuscript.

Funding: LM’s contribution to this work was funded by EPSRC, grant number 0007327–PBIAA–LINCAM.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Searle, A.; Turnbull, J.; Oliver, C. Climate Cattle: Metabolic Intervention in the Good Anthropocene. *Environ. Humanit.* **2024**, *16*, 784–806. [\[CrossRef\]](#)
2. Min, B.R.; Lee, S.; Jung, H.; Miller, D.N.; Chen, R. Enteric methane emissions and animal performance in dairy and beef cattle production: Strategies, opportunities, and impact of reducing emissions. *Animals* **2022**, *12*, 948. [\[CrossRef\]](#) [\[PubMed\]](#)
3. Knapp, J.R.; Laur, G.L.; Vadas, P.A.; Weiss, W.P.; Tricarico, J.M. Invited review: Enteric methane in dairy cattle production: Quantifying the opportunities and impact of reducing emissions. *J. Dairy Sci.* **2014**, *97*, 3231–3261. [\[CrossRef\]](#)
4. van Gastelen, S.; Dijkstra, J.; Bannink, A. Are dietary strategies to mitigate enteric methane emission equally effective across dairy cattle, beef cattle, and sheep? *J. Dairy Sci.* **2019**, *102*, 6109–6130. [\[CrossRef\]](#) [\[PubMed\]](#)
5. Løvendahl, P.; Difford, G.F.; Li, B.; Chagunda, M.G.G.; Huhtanen, P.; Lidauer, M.H.; Lassen, J.; Lund, P. Selecting for improved feed efficiency and reduced methane emissions in dairy cattle. *Animal* **2018**, *12*, s336–s349. [\[CrossRef\]](#) [\[PubMed\]](#)

6. Manning, L.; Nayak, R. Carbon farming: Standards, good agricultural practices, reporting and verification activities. In *Improving Standards and Certification in Agri-Food Supply Chains: Ensuring Safety, Sustainability and Social Responsibility*; Manning, L., Ed.; Burleigh Dodds Science Publishing: Cambridge, UK, 2024; ISBN 9781801464512.
7. Bačėninaitė, D.; Džermeikaitė, K.; Antanaitis, R. Global warming and dairy cattle: How to control and reduce methane emission. *Animals* **2022**, *12*, 2687. [\[CrossRef\]](#)
8. Dijkstra, J.; Bannink, A.; France, J.; Kebreab, E.; Van Gastelen, S. Antimethanogenic effects of 3-nitrooxypropanol depend on supplementation dose, dietary fiber content, and cattle type. *J. Dairy Sci.* **2018**, *101*, 9041–9047. [\[CrossRef\]](#) [\[PubMed\]](#)
9. Scott, D. The magic bullet criticism of agricultural biotechnology. *J. Agric. Environ. Ethics* **2005**, *18*, 259–267. [\[CrossRef\]](#)
10. Manning, L. Innovating in an Uncertain World: Understanding the Social, Technical and Systemic Barriers to Farmers Adopting New Technologies. *Challenges* **2024**, *15*, 32. [\[CrossRef\]](#)
11. Manning, L.; Dooley, J.J.; Dunsford, I.; Goodman, M.K.; MacMillan, T.C.; Morgans, L.C.; Rose, D.C.; Sexton, A.E. Threat or opportunity? An analysis of perceptions of cultured meat in the UK farming sector. *Front. Sustain. Food Syst.* **2023**, *7*, 1–14. [\[CrossRef\]](#)
12. Webster, D.G. Scapegoats, silver bullets, and other pitfalls in the path to sustainability. *Elem. Sci. Anthr.* **2017**, *5*, 7. [\[CrossRef\]](#)
13. Otto, D.; Thoni, T.; Wittstock, F.; Beck, S. Exploring narratives on negative emissions technologies in the post-Paris era. *Front. Clim.* **2021**, *3*, 684135. [\[CrossRef\]](#)
14. Bharosa, N. The rise of GovTech: Trojan horse or blessing in disguise? A research agenda. *Gov. Inf. Q.* **2022**, *39*, 101692. [\[CrossRef\]](#)
15. Krauss, W.; Bremer, S. The role of place-based narratives of change in climate risk governance. *Clim. Risk Manag.* **2020**, *28*, 100221. [\[CrossRef\]](#)
16. Janković, V.; Schultz, D.M. Atmosfear: Communicating the effects of climate change on extreme weather. *Weather Clim. Soc.* **2017**, *9*, 27–37. [\[CrossRef\]](#)
17. Kundzewicz, Z.W.; Matczak, P.; Otto, I.M.; Otto, P.E. From “atmosfear” to climate action. *Environ. Sci. Policy* **2020**, *105*, 75–83. [\[CrossRef\]](#)
18. Abernethy, S.; Jackson, R.B. Atmospheric methane removal may reduce climate risks. *Environ. Res. Lett.* **2024**, *19*, 051001. [\[CrossRef\]](#)
19. Muhammad, M.; Stokes, J.E.; Morgans, L.; Manning, L. The social construction of narratives and arguments in animal welfare discourse and debate. *Animals* **2022**, *12*, 2582. [\[CrossRef\]](#)
20. Vigors, B.; Wemelsfelder, F.; Lawrence, A.B. What symbolizes a “good farmer” when it comes to farm animal welfare? *J. Rural. Stud.* **2023**, *98*, 159–170. [\[CrossRef\]](#)
21. Naylor, R.; Hamilton-Webb, A.; Little, R.; Maye, D. The ‘good farmer’: Farmer identities and the control of exotic livestock disease in England. *Sociol. Rural.* **2018**, *58*, 3–19. [\[CrossRef\]](#)
22. Grelet, G.; Lang, S.; Merfield, C.; Calhoun, N.; Robson-Williams, M.; Horrocks, A.; Dewes, A.; Clifford, A.; Stevenson, B.; Saunders, C.M.; et al. Regenerative Agriculture in Aotearoa New Zealand—Research Pathways to Build Science-Based Evidence and National Narratives. 2021. Available online: <https://researcharchive.lincoln.ac.nz/entities/publication/7854c298-1771-448e-8f56-9d460cf9b8a5> (accessed on 21 December 2024).
23. Riley, M. Still being the ‘good farmer’: (Non-)retirement and the preservation of farming identities in older age. *Sociol. Rural.* **2016**, *56*, 96–115. [\[CrossRef\]](#)
24. Schillo, R.S.; Robinson, R.M. Inclusive innovation in developed countries: The who, what, why, and how. *Technol. Innov. Manag. Rev.* **2017**, *7*, 34–46. [\[CrossRef\]](#)
25. Bronson, K. Looking through a responsible innovation lens at uneven engagements with digital farming. *NJAS-Wageningen. J. Life Sci.* **2019**, *90*, 100294. [\[CrossRef\]](#)
26. Fusar Poli, E.; Fontefrancesco, M.F. Trends in the implementation of biopesticides in the Euro-Mediterranean region: A narrative literary review. *Sustain. Earth Rev.* **2024**, *7*, 1–11. [\[CrossRef\]](#)
27. Anderson, M.D.; Rivera-Ferre, M. Food system narratives to end hunger: Extractive versus regenerative. *Curr. Opin. Environ. Sustain.* **2021**, *49*, 18–25. [\[CrossRef\]](#)
28. Manning, L.; Grant, J.H. Food safety management systems: Determining what is ‘safe enough’. *Trends Food Sci. Technol.* **2025**, *156*, 104811. [\[CrossRef\]](#)
29. Phillipov, M.; Goodman, M.K. The celebrification of farmers: Celebrity and the new politics of farming. *Celebr. Stud.* **2017**, *8*, 346–350. [\[CrossRef\]](#)
30. Goodman, M.K.; Johnston, J.; Cairns, K. Food, media and space: The mediated biopolitics of eating. *Geoforum* **2017**, *84*, 161–168. [\[CrossRef\]](#)
31. Hollows, J. *Celebrity Chefs, Food Media and the Politics of Eating*; Bloomsbury Publishing: London, UK, 2022.
32. Bäckstrand, K.; Lövbrand, E. The road to Paris: Contending climate governance discourses in the post-Copenhagen era. *J. Environ. Policy Plan.* **2019**, *21*, 519–532. [\[CrossRef\]](#)

33. Bäckstrand, K.; Lövbrand, E. Planting trees to mitigate climate change: Contested discourses of ecological modernization, green governmentality and civic environmentalism. *Glob. Environ. Politics* **2006**, *6*, 50–75. [\[CrossRef\]](#)
34. Rijswijk, K.; Klerkx, L.; Bacco, M.; Bartolini, F.; Bulten, E.; Debruyne, L.; Dessein, J.; Scotti, I.; Brunori, G. Digital transformation of agriculture and rural areas: A socio-cyber-physical system framework to support responsabilisation. *J. Rural Stud.* **2021**, *85*, 79–90. [\[CrossRef\]](#)
35. Goodman, M.K.; Wylie, A.; Sexton, A.E.; Lewis, K.; Rose, D.C.; MacMillan, T.; Manning, L. Analysis of The Narrative Grammars of Cultured Meat Across the UK Food and Farming Media. *Int. J. Sociol. Agric. Food* **2024**, *30*, 117–138. [\[CrossRef\]](#)
36. Suarez-Villa, L. The e-economy and the rise of technocapitalism: Networks, firms, and transportation. *Growth Change* **2003**, *34*, 390–414. [\[CrossRef\]](#)
37. Suarez-Villa, L. The rise of technocapitalism. *Sci. Technol. Stud.* **2001**, *14*, 4–20. [\[CrossRef\]](#)
38. Nestler, G. Contingent Claims: The performativity of finance, or how the future materializes in technocapitalism. *Perform. Res.* **2020**, *25*, 114–122. [\[CrossRef\]](#)
39. Clapp, J.; Scrinis, G. Big food, nutritionism, and corporate power. *Globalizations* **2017**, *14*, 578–595. [\[CrossRef\]](#)
40. Cullerton, K.; Patay, D.; Waller, M.; Adsett, E.; Lee, A. Competing public narratives in nutrition policy: Insights into the ideational barriers of public support for regulatory nutrition measures. *Health Res. Policy Syst.* **2022**, *20*, 86. [\[CrossRef\]](#)
41. Williams, S.N. The incursion of ‘Big Food’ in middle-income countries: A qualitative documentary case study analysis of the soft drinks industry in China and India. *Crit. Public Health* **2015**, *25*, 455–473. [\[CrossRef\]](#)
42. Lauber, K.; Rutter, H.; Gilmore, A.B. Big food and the World Health Organization: A qualitative study of industry attempts to influence global-level non-communicable disease policy. *BMJ Glob. Health* **2021**, *6*, e005216. [\[CrossRef\]](#)
43. Gunnarsson, J.A.; Ruskin, G.; Stuckler, D.; Steele, S. Big food and drink sponsorship of conferences and speakers: A case study of one multinational company’s influence over knowledge dissemination and professional engagement. *Public Health Nutr.* **2023**, *26*, 1094–1111. [\[CrossRef\]](#)
44. McGregor, A.; Rickards, L.; Houston, D.; Goodman, M.K.; Bojovic, M. The biopolitics of cattle methane emissions reduction: Governing life in a time of climate change. *Antipode* **2021**, *53*, 1161–1185. [\[CrossRef\]](#)
45. Williamson, H.F.; Hartley, S. Responsible development of digital livestock technologies for agricultural challenges: Purpose, practicality and effects are key considerations. *Sociol. Rural.* **2024**, *64*, 662–684. [\[CrossRef\]](#)
46. Kowalska, A.; Manning, L. Using the rapid alert system for food and feed: Potential benefits and problems on data interpretation. *Crit. Rev. Food Sci. Nutr.* **2021**, *61*, 906–919. [\[CrossRef\]](#)
47. Flick, U. *Doing Grounded Theory*; Sage Publications: Thousand Oaks, CA, USA, 2018.
48. Krippendorff, K. The changing landscape of content analysis: Reflections on social construction of reality and beyond. *Commun. Soc.* **2019**, *47*, 1–27.
49. Jones, R. *Discourse Analysis: A Resource Book for Students*, 2nd ed.; Routledge: Abingdon, UK, 2019.
50. Smith, R.; Manning, L.; McElwee, G. The anatomy of ‘So-called Food-Fraud Scandals’ in the UK 1970–2018: Developing a contextualised understanding. *Crime Law Soc. Change* **2022**, *78*, 535–558. [\[CrossRef\]](#)
51. Maitlis, S.; Christianson, M. Sensemaking in organizations: Taking stock and moving forward. *Acad. Manag. Ann.* **2014**, *8*, 57–125. [\[CrossRef\]](#)
52. Klein, G.; Eckhaus, E. Sensemaking and sensegiving as predicting organizational crisis. *Risk Manag.* **2017**, *19*, 225–244. [\[CrossRef\]](#)
53. Manning, L.; Birchmore, I.; Morris, W. Swans and elephants: A typology to capture the challenges of food supply chain risk assessment. *Trends Food Sci. Technol.* **2020**, *106*, 288–297. [\[CrossRef\]](#)
54. Hahn, T.; Preuss, L.; Pinkse, J.; Figge, F. Cognitive frames in corporate sustainability: Managerial sensemaking with paradoxical and business case frames. *Acad. Manag. Rev.* **2014**, *39*, 463–487. [\[CrossRef\]](#)
55. Bøhm, M. Learning Points from Real Incidents—Learning from What? Paper presented at Nordic Fire and Safety Days, København, Denmark. Available online: https://www.ucviden.dk/ws/portalfiles/portal/103180448/Learning_points_from_real_incidents_NFSD.pdf (accessed on 5 January 2025).
56. Stieglitz, S.; Bunker, D.; Mirbabaie, M.; Ehnis, C. Sense-making in social media during extreme events. *J. Contingencies Crisis Manag.* **2018**, *26*, 4–15. [\[CrossRef\]](#)
57. Mirbabaie, M.; Zapatka, E. Sensemaking in social media crisis communication—A case study on the Brussels bombings in 2016. In Proceedings of the 25th European Conference on Information Systems (ECIS), Guimarães, Portugal, 5–10 June 2017; pp. 2169–2186, ISBN 978-989-207655.
58. Blancke, S.; Boudry, M. “Trust Me, I’m a Scientist” How Philosophy of Science Can Help Explain Why Science Deserves Primacy in Dealing with Societal Problems. *Sci. Educ.* **2022**, *31*, 1141–1154. [\[CrossRef\]](#)
59. Fairbrother, M. Environmental attitudes and the politics of distrust. *Sociol. Compass* **2017**, *11*, e12482. [\[CrossRef\]](#)
60. Sarathchandra, D.; Haltinner, K.; Grindal, M. Climate skeptics’ identity construction and (Dis) trust in science in the United States. *Environ. Sociol.* **2022**, *8*, 25–40. [\[CrossRef\]](#)

61. Runnebaum, J.M.; Maxwell, E.A.; Stoll, J.S.; Pianka, K.E.; Oppenheim, N.G. Communication, relationships, and relatability influence stakeholder perceptions of credible science. *Fisheries* **2019**, *44*, 164–171. [CrossRef]
62. Diekman, C.; Ryan, C.D.; Oliver, T.L. Misinformation and disinformation in food science and nutrition: Impact on practice. *J. Nutr.* **2023**, *153*, 3–9. [CrossRef]
63. Fârte, G.I.; Obadă, D.R. The effects of fake news on consumers' brand trust: An exploratory study in the food security context. *Rom. J. Commun. Public Relat.* **2021**, *23*, 47–61. [CrossRef]
64. Konstantakis, K.N.; Cheilas, P.T.; Melissaropoulos, I.G.; Xidonas, P.; Michaelides, P.G. Supply chains and fake news: A novel input–output neural network approach for the US food sector. *Ann. Oper. Res.* **2023**, *327*, 779–794. [CrossRef]
65. Vaqué, L.G. Fake news in the food sector: Consumer distrust and unfair competition. *Eur. Food Feed L. Rev.* **2018**, *13*, 411.
66. Soon, J.M. Consumers' awareness and trust toward food safety news on social media in Malaysia. *J. Food Prot.* **2020**, *83*, 452–459. [CrossRef]
67. Shang, Z.; Tan, L.; Zhang, H.; Jiang, X.; Liu, Y.; Li, D. Food23: A Chinese Food Safety Dataset for Fake News Detection. In Proceedings of the 2023 7th International Conference on Advances in Artificial Intelligence, Istanbul, Turkey, 13–15 October 2023; pp. 86–91. [CrossRef]
68. Akhtar, P.; Ghouri, A.M.; Khan, H.U.R.; Amin ul Haq, M.; Awan, U.; Zahoor, N.; Khan, Z.; Ashraf, A. Detecting fake news and disinformation using artificial intelligence and machine learning to avoid supply chain disruptions. *Ann. Oper. Res.* **2023**, *327*, 633–657. [CrossRef]
69. Jiang, T.A.O.; Li, J.P.; Haq, A.U.; Saboor, A.; Ali, A. A novel stacking approach for accurate detection of fake news. *IEEE Access* **2021**, *9*, 22626–22639. [CrossRef]
70. Wang, Y.; Qian, S.; Hu, J.; Fang, Q.; Xu, C. Fake news detection via knowledge-driven multimodal graph convolutional networks. In Proceedings of the 2020 International Conference on Multimedia Retrieval, Dublin, Ireland, 8–11 June 2020; pp. 540–547. [CrossRef]
71. Zhou, X.; Jain, A.; Phoha, V.V.; Zafarani, R. Fake news early detection: A theory-driven model. *Digit. Threat. Res. Pract.* **2020**, *1*, 1–25. [CrossRef]
72. Wardle, C.; Derakhshan, H. Thinking about 'information disorder': Formats of misinformation, disinformation, and mal-information. In *Journalism, Fake News & Disinformation: Handbook for Journalism Education and Training*; UNESCO: Paris, France, 2018; pp. 43–54. Available online: <https://unesdoc.unesco.org/ark:/48223/pf0000265552> (accessed on 5 April 2025).
73. Chowdhury, A.; Kabir, K.H.; Abdulai, A.R.; Alam, M.F. Systematic review of misinformation in social and online media for the development of an analytical framework for agri-food sector. *Sustainability* **2023**, *15*, 4753. [CrossRef]
74. Santos-D'Amorim, K.; de Oliveira Miranda, M.K.F. Misinformation, disinformation, and malinformation: Clarifying the definitions and examples in disinfodemic times. *Encontros Bibli* **2021**, *26*, 1–23. [CrossRef]
75. Petratos, P.N.; Faccia, A. Fake news, misinformation, disinformation and supply chain risks and disruptions: Risk management and resilience using blockchain. *Ann. Oper. Res.* **2023**, *327*, 735–762. [CrossRef] [PubMed]
76. Pfeiffer, L.J.; Knobloch, N.A.; Tucker, M.A.; Hovey, M. Issues-360TM: An Analysis of Transformational Learning in a Controversial Issues Engagement Initiative. *J. Agric. Educ. Ext.* **2021**, *28*, 439–458. [CrossRef]
77. Chatterjee, S.; Chaudhuri, R.; Vrontis, D. Role of fake news and misinformation in supply chain disruption: Impact of technology competency as moderator. *Ann. Oper. Res.* **2023**, *327*, 659–682. [CrossRef]
78. Novo Vazquez, A.; Garcia-Espejo, I. Boycotting and buycotting food: New forms of political activism in Spain. *Br. Food J.* **2021**, *123*, 2492–2505. [CrossRef]
79. Arla Foods. A Message from Arla Foods on Bovaer. Available online: <https://www.arla.com/company/news-and-press/2024/news/a-message-from-arla-foods-on-bovaer/> (accessed on 5 April 2025).
80. Arla Foods. Projects Helping to Reduce Methane Emissions. Available online: <https://www.arlafoods.co.uk/arla-bovaer-statement/#are-you-still-running-bovaer-projects-on-your-farms-in-the-uk> (accessed on 5 April 2025).
81. FSA (Food Standards Agency). Bovaer Cow Feed Additive Explained. Available online: <https://food.blog.gov.uk/2024/12/05/bovaer-cow-feed-additive-explained/> (accessed on 5 April 2025).
82. World Health Organisation. Infodemic. 2025. Available online: https://www.who.int/health-topics/infodemic#tab=tab_1 (accessed on 2 February 2025).
83. Taguchi, K.; Matsoso, P.; Driece, R.; da Silva Nunes, T.; Soliman, A.; Tangcharoensathien, V. Effective infodemic management: A substantive article of the pandemic accord. *JMIR Infodemiology* **2023**, *3*, e5176. [CrossRef]
84. Calleja, N.; AbdAllah, A.; Abad, N.; Ahmed, N.; Albarracin, D.; Altieri, E.; Anoko, J.N.; Arcos, R.; Azlan, A.A.; Bayer, J.; et al. A public health research agenda for managing infodemics: Methods and results of the first WHO infodemiology conference. *JMIR Infodemiology* **2021**, *1*, e30979. [CrossRef]
85. Purnat, T.D.; Wilson, H.; Nguyen, T.; Briand, S. Ears—A WHO platform for AI-supported real-time online Social Listening of COVID-19 conversations. In *Public Health and Informatics*; IOS Press: Amsterdam, The Netherlands, 2021; pp. 1009–1010. [CrossRef]

86. Terefe, G.; Walelegne, M. Assessing the impact of climate action mitigation strategies from livestock production: A review—Solution for greenhouse gases mitigation. *CABI Rev.* **2024**, *19*, 1–5. [[CrossRef](#)]
87. Johansen, M.; Maigaard, M.; Lund, P. Effect of Bovaer inclusion in diets with high proportion of grass-clover silage of different nutritional quality on gas emissions and production performance in dairy cows. *J. Dairy Sci.* **2025**, *108*, 4975–4987. [[CrossRef](#)] [[PubMed](#)]
88. Ma, X.; Räisänen, S.E.; Garcia-Ascolani, M.E.; Bobkov, M.; He, T.; Islam, M.Z.; Li, Y.; Peng, R.; Reichenbach, M.; Serviento, A.M.; et al. Effects of 3-nitrooxypropanol (Bovaer) and whole cottonseed on milk production and enteric methane emissions from dairy cows under Swiss management conditions. *J. Dairy Sci.* **2024**, *107*, 6817–6833. [[CrossRef](#)] [[PubMed](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.