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Who is responsible for fixing the food system? A framing analysis of media reactions to the UK's National Food Strategy

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Abstract

Purpose – High levels of child obesity alongside rising stunting and the absence of a coherent food policy have deemed UK's food system to be broken. The National Food Strategy (NFS) was debated intensely in media, with discussions on how and who should fix the food system.

Design/methodology/approach – Using a mixed methods approach, the authors conduct framing analysis on traditional media and sentiment analysis of twitter reactions to the NFS to identify frames used to shape food system policy interventions.

Findings – The study finds evidence that the media coverage of the NFS often utilised the tropes of “culture wars” shaping the debate of who is responsible to fix the food system – the government, the public or the industry. NFS recommendations were portrayed as issues of free choice to shift the debate away from government action correcting for market failure. In contrast, the industry was showcased as equipped to intervene on its own accord. Dietary recommendations made by the NFS were depicted as hurting the poor, painting a picture of helplessness and loss of control, while their voices were omitted and not represented in traditional media.

Social implications – British media's alignment with free market economic thinking has implications for food systems reform, as it deters the government from acting and relies on the invisible hand of the market to fix the system. Media firms should move beyond tropes of culture wars to discuss interventions that reform the structural causes of the UK's broken food systems.

Originality/value – As traditional media coverage struggles to capture the diversity of public perception; the authors supplement framing analysis with sentiment analysis of Twitter data. To the best of our knowledge, no such media (and social media) analysis of the NFS has been conducted. The paper is also original as it extends our understanding of how media alignment with free market economic thinking has implications for food systems reform, as it deters the government from acting and relies on the invisible hand of the market to fix the system.

Keywords Food systems, UK media, Framing analysis, Twitter sentiment analysis, Market failure

Paper type Research paper

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Introduction

High levels of child obesity alongside rising stunting and the absence of a coherent UK food policy have deemed UK's food system to be broken ([The Food Foundation, 2022](#)). To fill this policy coherence gap, the UK government commissioned an independent review to draw a National Food Strategy (NFS) for England and the devolved nations. The much-anticipated strategy, led by Henry Dimbleby, a prominent British entrepreneur and food writer who restaurant chain Leon, submitted 14 recommendations to the government to reform the UK's food system. Whilst the NFS received accolades, particularly regarding its focus on child food poverty, it also received criticisms and was hotly debated in press. Perhaps the biggest setback to the enthusiasm came directly from the government that commissioned the report and its then Prime Minister, Boris Johnson, who dismissed the implementation of the NFS's key recommendations ([Walker and Butler, 2021](#)).

The media has the capability to shape both public opinions and policy direction through their framings, by constructing a narrative to encourage a particular interpretation of an issue ([Entman, 2007](#); [Panagiotopoulos et al., 2017](#); [Strong and Wells, 2020](#); [Yau et al., 2021](#)). Media can "set the agenda" for the public by promoting an issue over others ([Cobb and Elder, 1980](#); [Entman, 1993, 2003](#)) and/or by representing (or "framing" or "angling") an issue in a specific way ([Entman, 2007](#); [Goffman, 1986](#)). Evidence suggests that in relation to public health challenges, the media are more likely to assign responsibility to consumers than government or industry ([Kristiansen et al., 2021](#); [Mroz and Painter, 2022](#)). This focus on individual choice and consumer behaviour shifts the discourse away from interventions targeted at structural causes of the broken food system to issues of free choice ([Mroz and Painter, 2022](#)). In the context of post-Brexit [1] changes to farming and trade practices, an analysis of the media and public discourse on food system reforms is a valuable topic for analysis.

This paper aims to analyse the reactions to the NFS through a framing analysis of media and press coverage to identify key debates and reactions surrounding the NFS in British media including newspapers and trade press. We pay particular attention to the 14 NFS recommendations and the frames used to allocate roles and responsibilities of stakeholders in food system reform. As traditional media coverage struggles to capture the diversity of public perception, particularly in quantity and intensity, we supplement framing analysis with sentiment analysis of Twitter data on reactions towards livestock farming policies specifically focussing on debates of trade, Brexit and the NFS. To the best of our knowledge, no such media (and social media) analysis of the NFS has been conducted.

This paper contributes to existing literature on food system policies by (1) identifying the frames used to shift narratives surrounding food systems reform in the UK and who is responsible and (2) extending the understanding of how media alignment with free market economic thinking has implications for food systems reform, as it deters the government from acting and relies on the invisible hand of the market to fix the system. We ask four core research questions in order to respond to the aim of the research:

- RQ1.* What were the dominant narratives surrounding the NFS? How were these narratives framed by British media?
- RQ2.* Whose voices are represented (and omitted) in the future of UK food systems media discourse?
- RQ3.* Which stakeholders does the media hold responsible to reform the food system? And which frames do media use to shape debates on food systems reform?
- RQ4.* How are the reactions towards livestock farming and environmental policies in the context of trade, Brexit and the NFS framed on Twitter?

Literature review

While media can help make sense of complex societal issues, it can also distort or decontextualize news information (Reese, 2007). In media studies, frames are defined as “ideational lenses through which problems are understood and portrayed” (Smith and Shiffman, 2016). Identification of frames helps “explain how the media structure their delivery of news, promoting certain interpretations of events by selecting certain facts” (Entman, 1993, 2007). Media frames can reveal how societal issues are presented to the public and ascertain the cues and signals used to make sense of complex societal challenges (Buddle and Bray, 2019) such as the food systems.

The media holds significant power in selecting issues of importance and how they are problematized through the narratives that are presented in the public agenda (Crow and Lawlor, 2016). Framing analysis has been employed previously to capture how industry uses media to shift conversation around consumption of certain products such as tobacco and meat. For example, in Australia, the meat industry was found to frame conversations about red and processed meat reduction as driven by a “Vegan Agenda” or as an elite minority issue. The industry also presented meat reduction “as an infringement on personal choice and traditional values” (Sievert *et al.*, 2021). Other studies have found that the meat industry frames the narrative surrounding livestock to minimise perceptions of harm to the environment and human health by employing similar framing tactics to tobacco and fossil fuel industries (Christen, 2021; Clare *et al.*, 2022; Dunne, 2021), while the alternative protein industry frames conventional livestock systems as outdated, broken and cruel (Sexton *et al.* (2019). Two studies assessing the media messages of meat–environment nexus in the UK found that the media were more likely to assign responsibility to consumers than the industry or the government (Kristiansen *et al.*, 2021; Mroz and Painter, 2022). Furthermore, climate change solutions posed by the media often focused on reduction in meat consumption by consumers rather than interventions to tackle structural causes of the problem, such as changes to livestock production practices, regulation or taxes (Kristiansen *et al.*, 2021). Implementing such technology or policy fixes in isolation from structural causes will be insufficient to fix the broken food system (Conti *et al.*, 2021; Hambloch *et al.*, 2023).

Framing analysis has also been employed to explore media portrayal of food and health-related inequalities. For example, in the UK, Wells and Caraher (2014) analysed media discourse of food banks, finding that user voices were largely absent while politicians and celebrities were prominently featured, i.e. privileging certain voices over others. Wells (2017) found that the UK media coverage of nutritional means of preventing bowel cancer was primarily set in the “lifestyle” frame indicating that the responsibility for increasing dietary fibre was of the individual instead of discussions of structural drivers of dietary change such as social, economic or political drivers. In a more recent study, Yau *et al.* (2021) found that the issue of food insecurity in the UK was predominantly covered by left-leaning and centrist newspapers. These papers are predisposed to view societal issues as structural instead of individual framed food insecurity as a structural challenge and called for government action (White, 2010; Yau *et al.*, 2021).

Analytical framework

To analyse data from both traditional and social media we use a framing analysis framework. Marais and Linström (2012) categorise frames into rhetorical and technical devices. Rhetorical devices are used “to make something look more like one thing than another” (Stone, 2013). These are usually in forms of word choice, metaphors, stock phrases that “provide thematically reinforcing clusters of facts or judgement” (Entman, 1993). While technical devices are elements of writing, layout and visuals used to make a point in media articles. These include page placement of an article or photographs that may set the visual tone of the piece. Technical devices also include sources of information – such as quoting experts to claim empirical validity of facts, linking to official sources/government circulars – who is quoted and how they are identified. A variety of both rhetorical and technical devices

are used to frame reportage on public issues of obesity, nutrition, tobacco consumption, food bank use and food insecurity. Table 1 summarises frames identified in existing literature of media reporting of public health policy. We conduct thematic analysis of the media data to identify the frames in Table 1 used by media.

Methods

Media coverage of the NFS was retrieved from Factiva and analysed using a mixed methods approach, including quantitative descriptors and qualitative thematic analysis. Data from Twitter was also collected to capture public perceptions. Although there is sampling bias based on the specific demographics of Twitter, the social media platform can provide insights on partial perception of topics of interest among the “general public” (Cui and He, 2021). As media coverage of livestock and farming recommendations was limited, the Twitter Sentiment Analysis (TSA) was focused on perception of NFS in relation to livestock farming policies debates on trade and Brexit. In doing so, we identified sentiments and themes emerging on the future of the UK’s food system.

Framing analysis

We used Factiva to identify news and media articles related to the NFS through a search string “national food strateg*”. All articles published from two weeks prior to and until

Frames	References
1 Focus on free choice over structural determinants of the cause <ul style="list-style-type: none"> • Focus on individual responsibility, lifestyle change and victim blaming, arguing that producers and retailers are not responsible • Portray government intervention a “nanny state-ism” that undermines consumers free will (rhetorical device of phrases) 	Moodie <i>et al.</i> (2013), Mialon <i>et al.</i> (2015), Clare <i>et al.</i> (2022), Yau <i>et al.</i> (2021), Wells (2017) Moodie <i>et al.</i> (2013)
2 Stories of decline <ul style="list-style-type: none"> • Destroying cultural identities and traditional values (rhetorical device) 	Sievert <i>et al.</i> (2021)
3 Stories of helplessness and control <ul style="list-style-type: none"> • Reducing consumption hurts the poor who are already struggling 	Sievert <i>et al.</i> (2021)
4 Efforts to shape understanding of evidence <ul style="list-style-type: none"> • Cherry pick data that favours an argument • Portray evidence as uncertain and lacking consensus • Describe outcomes as complex and not attributable 	Mialon <i>et al.</i> (2015) Clare <i>et al.</i> (2022) Clare <i>et al.</i> (2022)
5 Portray industry as well-intentioned and focus on steps they are taking to manage harms <ul style="list-style-type: none"> • Promote the good intentions and stress the good traits of the industry • Emphasise the food industry’s actions to address public health-related issues 	Mialon <i>et al.</i> (2015) Clare <i>et al.</i> (2022) Moodie <i>et al.</i> (2013)
6 Privileging of certain voices and omission of others <ul style="list-style-type: none"> • Omit voices of certain groups such as citizens • Giving space to politicians and industry groups • Universalising a group’s experience with one individual 	Wells and Caraher (2014) Wells (2017) Wells (2017)

Table 1. Framing devices identified in existing literature

Note(s): Adapted from literature by authors

Source(s): Authors work

6 months after the release of the NFS on 14th July 2021 were included. That is, between 1st July 2021 and 24th January 2022. As the NFS is an independent review of England's food system, the search was restricted to articles published in English only. We originally restricted the search to the UK region only but realised a small number of articles published outside the region were also relevant.

Factiva identified 302 duplicates (identical and similar), which were removed. KB then conducted a screening process whereby other duplicates or repeats (i.e. the same article or very similar articles presented slightly differently with no new information) and those deemed to be out of scope (i.e. where the NFS was not the central focus) were removed. MT screened a random sample (11%) of the articles to assess interrater agreement. There was only 2.6% disagreement, which was discussed and resolved. Given the subjective nature of the full text eligibility assessment both KB and MT reviewed all remaining 344 articles to ensure interrater reliability using the inclusion/exclusion criteria in [Table 2](#). Discrepancies were discussed and resolved between KB and MT. Commentary from the devolved nations and outside of the UK were included so long as the discussion focused on England's NFS. Further details on methods are included in section S1 in supplementary files.

Twitter sentiment and thematic analysis

To perform TSA, we used the Twitter API v2 on academic license to retrieve historical tweets on the topics of NFS, trade and Brexit-related livestock farming policies. Due to the cap on tweet data retrieval from Twitter API (<https://developer.twitter.com/>) we split the search string in two. The first string captured tweets related to trade or Brexit and second related to NFS and post-Brexit agriculture policies, we identified through a policy document search. Other criteria included (1) time period from 19th February 2021 to 19th February 2022 to assure that the tweets obtained were within the time window of both pre- and post-publication of the NFS; (2) the tweets were restricted to Great Britain; (3) tweet language was English to ensure machine learning reliability; and (4) must not be a retweet to ensure that unique perspectives were captured rather than collective concordance. The tweet retrieval and classification workflow is shown in [Figures 5 and 6](#).

After removing the duplicates, we used the support vector machine (SVM) algorithm to classify relevant and irrelevant tweets based on a subset trained manually. The relevant tweets had their sentiment analysed using bi-directional long short-term memory machine learning technique ([Zhang et al., 2018](#)). Each tweet was then classified based on the user information into a stakeholder category. Tweets were assigned into at least one of the following *a priori* codes (see [Table 3](#) in supplementary file for details).

We analysed overall sentiment – positive, neutral or negative – from tweets through machine learning techniques ([Zimbra et al., 2018](#)). Although machine learning and procedural classification carry both human and statistical errors, the objective of the analysis is to compose a broad image of the subjective public perception and how different stakeholders, e.g. academics or general public, echo their views of the policy proposal and implementation. To overcome this issue – as much as possible – the three authors (MT, KB and JM) classified the training dataset independently and only kept the trained data when the classification converged. Similar methods have been used in previous studies ([Cambria et al., 2017](#); [Giachanou and Crestani, 2016](#)). Further details on TSA methods are included in [section S2, 3 and 4](#) in supplementary files.

Results of framing analysis

In total, 966 articles were identified using a Factiva search. After the screening and full text eligibility assessment, 248 records were included in the analysis. The full identification, screening, eligibility and inclusion process can be seen in [Figure 1](#).

Table 2.
Description,
classification, political
stance and sentiment of
the top 10 publishers

Publishers	Description	Publication classification	Political stance	Positive	Negative	Neutral	Mixed	Total(%)
The Grocer	Weekly magazine with news and features on the grocery industry	Business paper*	ND	8	7	5	12	32 (12.9)
The Times Group	National daily broadsheet newspaper covering general, political and business news	National Newspaper – Quality σ	Right $^{\circ}$	8	3	2	7	20 (8.1)
Independent Print Limited	National newspaper providing a wide range news on politics, economics and business	National Newspaper – Quality σ	Centre $^{\circ}$	10	4	2	3	19 (7.7)
Daily Mail and General Trust	National tabloid newspaper covering news, politics, general interest and business	National Newspaper – Quality*	Right $^{\wedge}$	4	8	2	4	18 (7.3)
Telegraph Media Group	UK national newspaper providing news as well as in-depth comment and analysis from the editorial team	National Newspaper – Quality σ	Right $^{\circ}$	4	6	2	3	15 (6.0)
PA Media	UK News, Financial News and Parliamentary News from the Press Association	Press Association*	ND	5	1	2	4	12 (4.8)
Express Newspapers	UK national newspaper	National Newspaper – Mid Market σ	Right $^{\circ}$	1	8	2	0	11 (4.4)
Farmers Weekly	News and views about farming with topical and technical information from independent experts designed to help farmers	Business magazine σ	ND	3	2	1	4	10 (4.0)
WRBM Global	News from the food manufacturing markets, catered to a global audience	Business paper*	ND	4	0	1	3	8 (3.2)
Food Guardian Media Group	UK national newspaper covering world affairs, politics, economics and business, with an interest in social issues	National Newspaper – Quality σ	Left $^{\circ}$	2	0	1	4	7 (2.8)
Others				35	25	16	20	96 (38.7)
Total (%)				84 (33.9)	64 (25.8)	36 (14.5)	64 (25.8)	248 (100)

Note(s): σ ABC (Audit Bureau of Circulations) classification (based on [Yau et al., 2021](#) presented in supplementary documents), * Authors classification based on ABC definitions, $^{\wedge}$ **Source(s):** [Buttler and Buttler, \(2000\)](#); [Yau et al., \(2021\)](#); ND – Not defined
Authors work

Theme	Example tweets (paraphrased to maintain anonymity)	Sentiment
Brexit	Brexit could improve New Zealand standards through UK consumer power	Positive
	Brexit offers no benefits, Conservatives have created a mess, taken away freedoms, and destroyed fishing and farming industries	Negative
Trade	New trade deals could destroy the British food sector, leaving the UK dependent on other countries to feed itself	Negative
Australia/New Zealand trade deal	The UK government is denying citizens the right to vote on joining a trade block that forces the UK to drop animal welfare and food standards and destroys British farms	Negative
Animal Welfare	Delighted that the Sustainable Farming Incentive now includes better animal welfare and health standards	Positive
	According to the RSPCA, barren battery cages, sow stalls, hormone-fed beef, hot branding and mulesing are all legal in Australia, but banned or illegal in the UK	Negative

Note(s): The tweets are paraphrased by authors in order to protect individual users
Source(s): Authors work

Table 3. Example of tweets by themes and sentiment

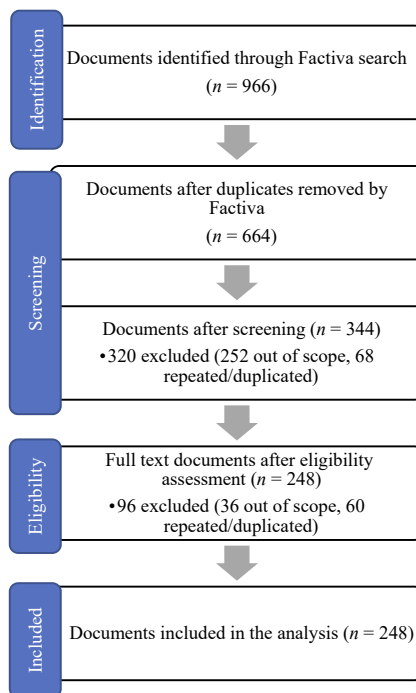


Figure 1. Identification, screening, eligibility and inclusion process for collating articles for analysis

Overall sentiment towards the NFS

Overall, more articles had a positive sentiment towards the NFS than negative, 34 and 26% respectively (Figure 2). However, 40% of the articles were either neutral or mixed in sentiment. Table 2 presents the distribution of articles by top publishers and their overall sentiments. The Grocer, a food industry magazine had the highest number of articles (13%),

followed by The Times Group (8%), Independent Print Limited (8%) and Daily Mail and General Trust (7%). Except for The Times Group, all other right-leaning media groups were critical of the NFS. The right-leaning articles that were mostly critical of the NFS accounted for about a fifth of the coverage. The centrist and left-leaning publishers had more positive or mixed sentiments but accounted for only 10% of the coverage. A fifth of the coverage was by business and industry publishers. They presented a balanced view with slightly more positive than negative coverage and a high share of mixed and neutral sentiment.

Coverage of NFS recommendations

The UK's NFS included 14 recommendations grouped into four main areas. The first group focuses on "Escape the junk food cycle and protect the NHS" and suggests implementing a Sugar and Salt Reformulation Tax, mandatory reporting for large food companies and launching an "Eat and Learn" initiative for schools. The second group aims to "Reduce diet-related inequality" through extending eligibility for free school meals, funding the Holiday Activities and Food program, expanding the Healthy Start scheme and trailing a "Community Eatwell" program. The third group, "Make the best use of our land," recommends guaranteeing agricultural payments, creating a Rural Land Use Framework and defining trade standards. Lastly, the fourth group, "Create a long-term shift in our food culture," advises investing in innovation, establishing a National Food System Data program, strengthening government procurement rules for healthy and sustainable food, and setting clear targets with legislation for long-term change.

As shown in Figure 3, the primary focus of the coverage was the sugar and salt reformulation tax as it was mentioned in 58% of the articles. The Community Eatwell and Free School Meal programme recommendations, which were topical due to footballer, Marcus Rashford's [2] interventions in the summer of 2021, were mentioned in approximately 20% of the articles. Less than 20% of the articles discussed standards for trade post-Brexit. Given the public concerns over post-Brexit trade standards and beef imports from New Zealand prior to the release of NFS in 2021, the low level of coverage in comparison to the sugar and salt reformulation tax is noteworthy.

The sugar and salt reformulation tax received significant media attention with 33% of articles expressing negative sentiment towards the proposal, 22% positive, 33% mixed and 13% neutral. Conservative Party politicians, including the former Prime Minister, Boris Johnson and the former Chancellor of the Exchequer, Rishi Sunak opposed the tax, as did the Food and Drink Federation's (FDF) (a membership organisation that represents food and drink manufacturers) chief scientific officer, Kate Halliwell, who suggested that the tax would not drive reformulation and that money raised would likely not be ring-fenced for intended health plans. However, health charities, including the Campaign "Action on Sugar", the British Heart Foundation and the British Medical Association (BMA) among others supported the tax policy as voluntary sugar reduction programs had limited success in reducing sugar consumption.

The recommendation to expand the free school meals programme was positively received and supported by footballer Marcus Rashford. Several articles discussed how the former Chancellor, Rishi Sunak, appeared to reject calls to extend free school meal into the school

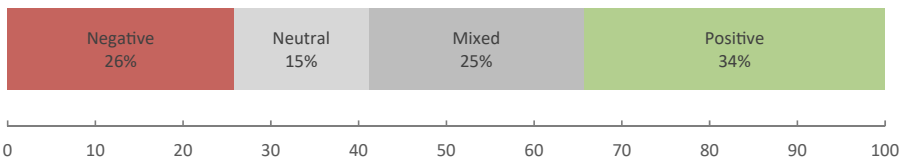
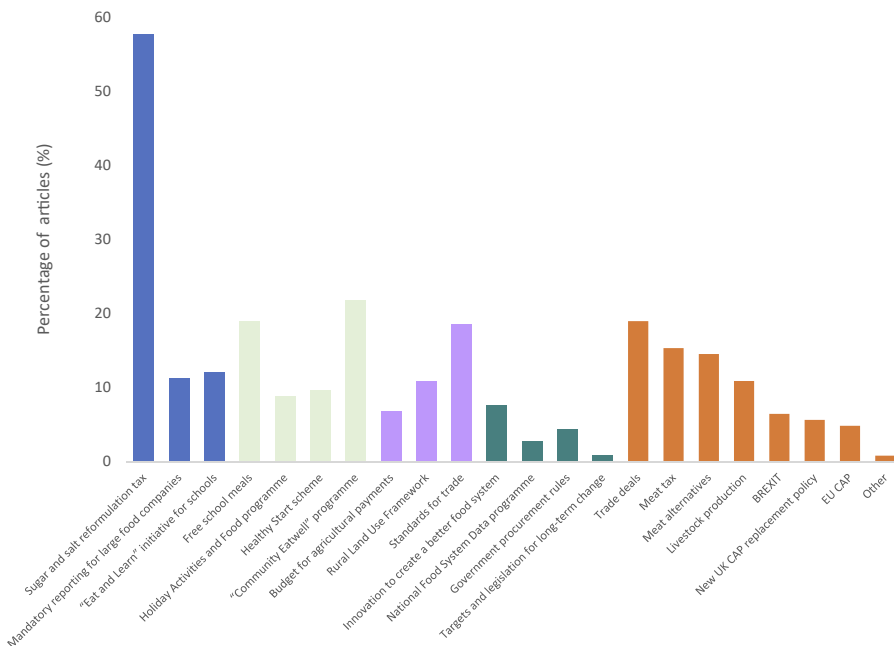


Figure 2.
Sentiment of articles
towards the NFS



Note(s): Each recommendation theme is coloured differently. Theme 1 - Blue, theme 2 - light green, theme 3 - purple, theme 4 - green, additional themes - orange

Figure 3.
Media articles by NFS
recommendations and
additional themes

holidays for the next three years, framing Sunak in conflict with Rashford with headlines like “Rish v Rash clash over meal cash” and “We stand with Rashford on feeding children. Will you, Rishi?” Apart from the fiscal criticism, the recommendation was critiqued for not tackling the structural roots of poverty that contribute to food insecurity.

The “Community Eatwell” programme recommendation, which gives GPs the ability to prescribe free fruit and vegetables, food-related education and social support, was discussed in 22% of the articles with mostly positive reception, particularly for its ability to reduce food poverty and to provide micronutrient dense healthy food. However, it was suggested that other structural factors, such as inadequate food storage and preparation facilities, should also be considered as part of the solution. The healthcare sector was less supportive due to existing pressures on the NHS.

The recommendation to guarantee budget for agricultural payments until at least 2029, replacing the EU CAP, was welcomed. Discussions revolved around “sustainable” use of land by removing land from agricultural production at the expense of UK’s ability to feed itself and further intensification of less portion of cultivated land.

The recommendation to define minimum standards for trade and create a mechanism for protecting standards were discussed in approximately 20% of the articles. Many stakeholders discussed the urgent need to protect British farmers from imports with lower environmental and animal welfare standards. Compensation to farmers affected by cheaper imports was raised by academics, a labour Member of Parliament (MP) and the National Farmers Union (NFU) that represents farmers in England and Wales.

The recommendation of a National Food System data programme which would see various government agencies collaborating was described as suspicious by supplier according to FDF boss, Ian Wright.

Finally, the NFS made a recommendation to reduce UK's meat consumption by 30% by 2032. Although the NFS did not directly recommend the introduction of a meat tax, one was explored during the consultation phase. Dimpleby warned that Britons may have to pay a meat tax at some point in the future to help save the planet despite recognising strong opposition. Several articles picked up on this narrative. The Institute of Economic Affairs, free market think tank, strongly opposed a meat tax. Many academic commentators agreed that the UK needed to reduce meat consumption and tax it in the near future. Certain commentators, including Dr Carys Bennett from People for the Ethical Treatment of Animals (PETA), an international animal rights organisation, and Andrew Kuyk, director general at Provision Trade Federation, who represents UK's dairy industry and dairy-related businesses, criticised the recommendations suggesting they did not go far enough to action change and meet the meat and climate reduction targets.

Power, politics and stakeholder voices in the media debate

Henry Dimpleby was the most frequently mentioned stakeholder in the media coverage of the NFS with 595 mentions, but the focus was often on his personality rather than the NFS recommendations. Some articles criticised his powerful position, with 33 referring to him as a "food tsar" and others highlighting his Eton and Oxford education and political connections.

Politicians were another prominent group in the media coverage, being quoted or mentioned 236 times. The sentiment towards NFS tended to fall along party lines, with the Conservative Party, representing 91% of mentions, generally being critical of the NFS or defending upcoming meat trade deals. The former Prime Minister, Boris Johnson, accounted for nearly half of all politician mentions (46%), largely criticising the sugar and salt reformulation tax. Conservative MPs Mordaunt and Trevelyan defended the UK's post-Brexit trade deals, highlighting negotiations surrounding food safety and welfare standards, and expressing confidence that the safeguards would support sensitive parts of the UK farming community.

Not all Conservative MPs opposed the NFS, with George Eustice, former Secretary of State for Environment, Food and Rural Affairs, thanking Dimpleby and his team for their work, and MPs Iain Duncan Smith and Robert Halfon supporting the recommendation to extend the Healthy Start Scheme. The former health minister Lord Bethell agreed to "*crack down on things like highly processed foods*". MP Neil Hudson equated the UK's free trade agreement with Australia to the Ashes cricket series, which "*is a bit one-sided in favour of Australia*". The Opposition parties received little coverage with less than 10% of mentions, which included the Labour Party (7%), Green Party (2%) and the Liberal Democrat Party (1%) being rarely quoted (Figure 4).

Privileging of certain voices

We observed the following frames were used to privilege certain voices and omit others– i) giving space to politicians and industry groups – majority of the politicians quoted were Conservatives; and ii) omit voices of certain groups such as citizens – consumers were discussed but without any direct voices/quotes from the group. Overall, we found privileging of certain voices, with stakeholders from academia and charities generally being pro NFS and politicians primarily Conservative government and certain sectors of the food industry – such as the Drinks federation and right-wing economic think tanks – voices were largely critical of the NFS. The stakeholders quoted represent power structures in the society, as consumer and people's voices were lacking (Wells and Caraher, 2014). Noting which voices were absent and present is critical to analysing narrative formation by the media.

British charities and non-profit organisations, such as Sustain, The Food Foundation, The Soil Association, Action on Salt, Action on Sugar and British Heart Foundation, welcomed the NFS recommendations and were frequently quoted in the media (47, 29, 14, 9, 8, and 4 mentions respectively). However, industry bodies like The FDF and NFU (22 and 20 mentions

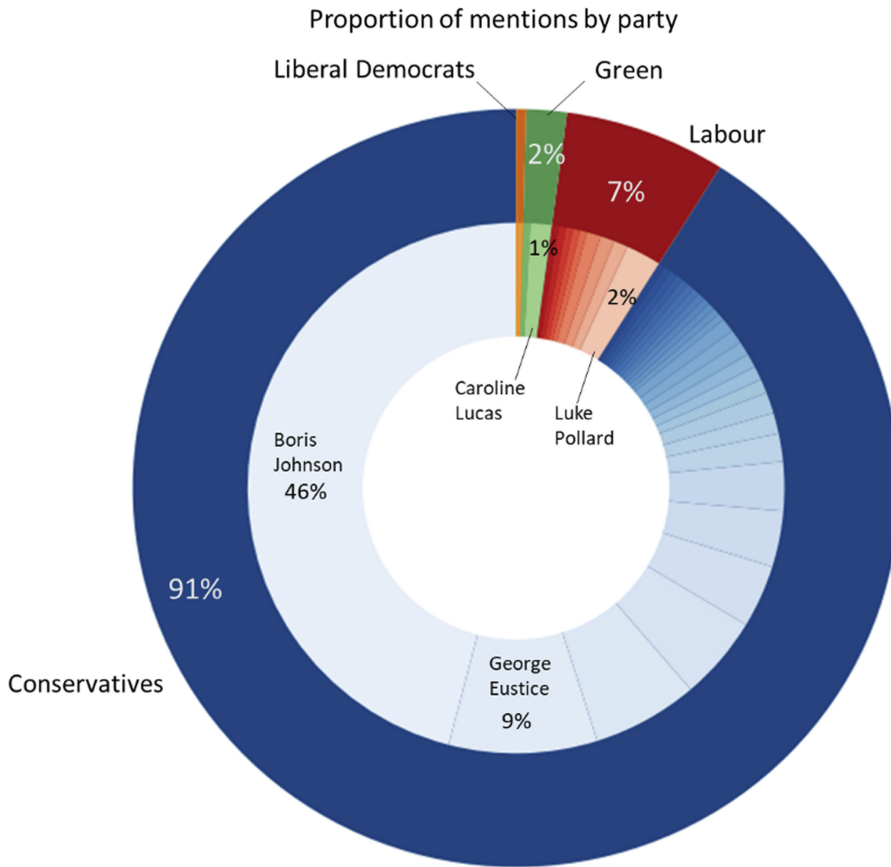


Figure 4. Percentage of mentions by political party and MPs

respectively) criticised the NFS for wanting to regulate the market. Free-market think tanks, such as the Institute of Economic Affairs and Adam Smith Institute, were also quoted several times (11 and 7 times respectively) in the right-leaning media sources criticising the NFS's obesity recommendations, primarily using the rhetorical framing of free choice over structural determinants of the problem. Interestingly, these two think tanks are not active in food policy sphere, but are frequently quoted, showcasing the privileging of certain voices by the UK media. This reflects source selection in order to favour one perspective over another (frame 4 in Table 1).

In addition to politicians and charities sector, academics and celebrity voices also dominated media discussions whilst the diversity of consumers, farming and rural communities were frequently underrepresented. While the farming and rural community were hugely impacted by changes to the food systems since Brexit and the COVID-19 pandemic. There was underrepresentation of these struggles and the possible impact of NFS recommendations on these communities.

Class, poverty and the role of state

The media focused on class and poverty, particularly in relation to the recommendation for the sugar and salt reformulation tax, and other diet-related inequality recommendations. Several right-leaning institutes and politicians framed the problem in a way that additional

taxes would harm poor people. Scaremongering through the use of loaded language – such as “carrot convoy”, “middle-class meddling” and “tsunami of new taxes” were prominent in the text. For example, the Taxpayers’ Alliance suggested that the tax could cost shoppers £4.8 billion a year. Conservative MP David Davis also described “eye-wateringly large tax increases” that will put “the price of things up for poor people” and worsen diets further. Such claims were not substantiated by references of evidence. The Sun and The Express used the price of popular food items to exemplify the possible impact of such a tax, e.g. “the price of a McDonald’s Big Mac soar by 20p”. One article further provoked the fear of escalation: “If the proposed tax on poor people’s snacks is pushed through to ‘save the NHS’, what is to stop another Government taxing or banning meat outright to ‘save the climate’”. These are examples of the use of free choice over structural determinants of the cause frame (frame 1 in Table 1) while using scaremongering tactics. Some articles were also critical of government intervention as they used framing manipulation to emphasise “free choice” of individuals and portray government intervention as “nanny state-ism” (frame 1 in Table 1).

Right-leaning think tanks, such as the IEA and TaxPayers “Alliance have strongly criticised the sugar and salt reformulation tax proposal”, with Christopher Snowdon claiming that “rich people want to clobber ordinary people with stealth taxes”, and John O’Connell suggesting that it would be “yet another case of middle-class meddling that will hit the poorest families hardest”. These narratives portray the tax as a form of control over ordinary people and reinforce a sense of helplessness (frame 3 in Table 1).

In contrast, academics, food charities, campaigners and left-leaning politicians argued that the NFS recommendations would tackle food-related health disparities in poorer areas and bring socio-economic benefits through free school meals, healthy holiday activities, healthy start and Community Eatwell schemes.

We found that overall, the articles discussed two opposite views of state intervention. Academia and charities sector called for the government to coordinate food systems change using a systems approach. While others used the frames of focusing on free choice over structural determinants of the cause by using rhetorical frames of catch phrases – “nanny state’ and ‘meddling’/middle-class meddling’ to portray government intervention to undermine consumer choice (frame 1 in Table 1).

Place-based approach and nostalgia for “British” products

The analysis also revealed the mainstreaming of local food systems, linking “Britishness” – i.e. production within Britain – with sustainability and “good” food systems. However, the assumption that short food supply chains equate to sustainability does not consider the complexities of factors like production methods, seasonal limitations, transportation and energy use. The articles also discussed the “superior” quality of British meat, the need to protect British food production, encourage self-sufficiency and reduce reliance on imports. Many stakeholders criticised recent trade deals for undermining British environmental and welfare standards.

The articles romanticised the British agricultural rural countryside. For example, Dimbleby recognised that sheep farms “are part of our national self-image those rolling green hills covered in fluffy white dots”. King Charles III, formerly known as Prince Charles at the time of the quote, also described that “If [small family farms] go, it will quite simply rip the heart out of the British countryside and break the backbone of Britain’s rural communities.” However, this traditional view of British agricultural countryside has also been challenged, with Oscar-winner Olivia Colman backing a film that calls for parts of the English countryside to be returned to the wild for the environment and wildlife.

In addition to nostalgia for British food, the articles emphasised the need to protect the NHS and pride in the NHS. The NHS was used as a source for health-related statistics to justify certain NFS recommendations and references were made to the financial burden of

diet related disease for the NHS. For example, Dimbleby discussed how the current food system was “putting intolerable strain on the NHS”.

Results of twitter sentiment analysis

Figures 5 and 6 depict the total number of relevant tweets ($n = 1259$) retrieved, filtered and classified by stakeholder category and sentiment. The relevant tweets mostly expressed neutral (331) and negative (870) sentiments. Only 58 tweets were classified as positive. The majority of tweets were categorised as from the “general public”, as opposed to the other categories. This was expected given the *de facto* occurrence of such stakeholders on social media. Table 3 presents examples of tweets by themes and sentiments.

Figure 7 shows the top 30 most frequent phrases in tweets from the general public. The findings add to our knowledge of public reactions to food system challenges by highlighting the key concerns and sentiments of the general public on social media. The high frequency of negative sentiment phrases such as “trade deal”, “post Brexit”, “New Zealand”, “farming fishing”, “labour shortage”, “supply chain” reflect the public’s concern about the impact of Brexit and new trade deals on the UK’s food, fishing and farming industries. Other common negative sentiment phrases like “animal welfare”, “hormone treated”, “animal suffer” and “live export” suggest that there is a growing concern among the public about the ethical treatment of animals in food production and the potential for reduced animal welfare standards as a result of Brexit and new trade deals.

Discussion

By conducting a comprehensive framing and sentiment analysis of media coverage on the NFS and post-Brexit food policies, this study has shed light on the way debates surrounding the UK’s food system are constructed and portrayed. Our findings identify the key debates

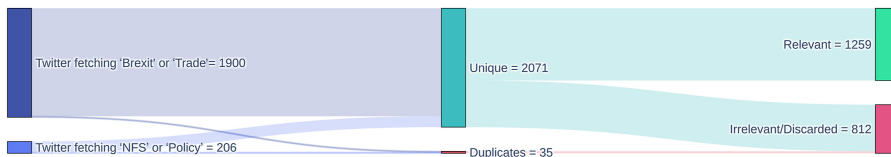


Figure 5.
Tweet search, classification and analysis workflow

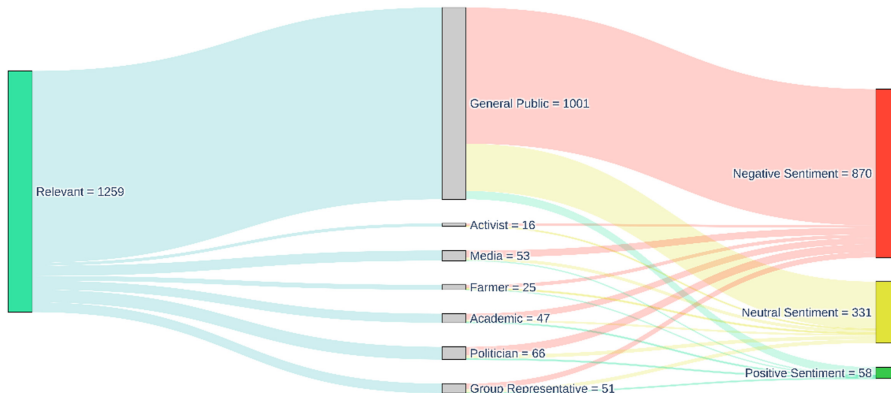


Figure 6.
Classification of relevant tweets

tobacco and alcoholic drinks labelling (Moodie *et al.*, 2021; Moodie *et al.*, 2013; Sievert *et al.*, 2021; Weishaar *et al.*, 2016; Yau *et al.*, 2021) and climate change (Walker *et al.*, 2020).

Industry actors, including food retailers, new entrants producing meat alternatives and finance investors were portrayed as well-intentioned and their actions to address public health-related issues were highlighted. At the same time, issues related to the negative externalities and trade-offs created by selling of cheap ultra-processed foods or alternatives such as ecological damage or consumer segregation were omitted. Sievert *et al.* (2021) also found this frame of projecting the red and processed meat industry as integral to solving the public health challenge without discussing the potential harmful effects and negative externalities occurring due to industry actions.

While by itself, the positive sentiments on actions taken by the corporate and private sector are not problematic, it should be analysed in relation to the portrayal of government intervention by media. The majority of the coverage of government intervention, including the commentary from The Conservative Party critiqued public health policy recommendations made by the NFS. The overall sentiment towards state intervention was negative. The rhetorical device of “nanny state-ism” was used to describe government intervention as curbing consumer free will. Coined by British politician, Iain Macleod in 1965, the metaphor was given further prominence by author and journalist, Auberon Waugh to oppose state intervention in relation to public health policies for tobacco smoking. The longevity of phrase usage suggested the popularity of the rhetorical device used by UK media. As such, longitudinal studies of media narratives can provide insights into changes or stagnation in sentiment and underlying sources of that generate positive or negative responses to policies.

Exaggerated and titillating headlines – such as “Sugar-tax goes sour: Why does the word ‘nanny’ terrify Tories?” and “Rish v Rash - Clash over meal cash” – were utilised to shift the debate away from the recommendations to reform UK's food system in favour of political ideologies often invoked by right-leaning media groups free market think tanks such as IEA and ASI. The depiction of state intervention as a problem could be due to the high share of coverage in right-leaning newspapers. The political leaning of the media sources influences the constructs used to depict social issues as related to individual freedom rather than structural ones (White, 2010). A systematic review of media coverage of non-communicable disease (NCD) debates found that the free choice framing – termed as market justice – was a common framing deployed by commercial stakeholders. While the population-level interventions representing social justice frames were used by public health advocates (Weishaar *et al.*, 2016). The contrasting reportage of the role of state vs the private sector reflects the choice of framing devices used by the UK media to depict public health debates as issues of free and individual choice, shift the debate away from government action to correct for market failure, while showcasing the private sector as equipped to intervene on its own accord. Our findings suggest that the UK media coverage of the NFS was aligned with free market economic thinking that deters from government action and relies on the invisible hand of the market to reform the system.

We also analyse the coverage in relation to power of stakeholder voices. Three key themes were identified in this relation included, i) prominence of sentiments across party lines, ii) labelling or tagging of stakeholders with extreme labels whilst applying mild or no labels to those of other persuasion and iii) omission of certain voices. Politicians were quoted 236 times in the 248 articles analysed. Over 90% of the politicians quoted were from the Conservative Party. Headlines and news articles commented on Henry Dimbleby's Oxbridge education and family wealth rather than the NFS. While food systems experts and research from various academic institutions and policy think tanks were quoted, certain voices were absent from the coverage. In particular, the diversity of farming and rural communities was frequently underrepresented. Apart from the NFU, individual farmer opinions were lacking in the articles we reviewed. Wells and Caraher (2014) in their study of media representation of food banks in the UK, also found that the opinions of the public and food bank users were omitted

in the media debates. Our study found that opinions of the so-called “poor” were depicted by right-leaning media groups as curbing their dietary freedom. A reduction in consumption of certain ultra-processed foods with high levels of sugar and salt content or meat was portrayed as hurting the poor who were already struggling and thus painting a picture of helplessness and loss of control.

While stories of helplessness were used to argue against state intervention, stories of decline were used to argue for interventions suggested in the NFS. “Britishness” was invoked as nostalgia for British food was conflated with sustainability. British food production was seen as more desirable and sustainable, despite this not always being the case. When advocating for nature restoration through rewilding, Dimbleby was quoted to suggest that he accepted the need to keep sheep farms that “are part of our national self-image those rolling green hills covered in fluffy white dots”. Another story of decline used to positively portray the NFS was the burden of obesity on the NHS and how the UK needed to “escape the junk food cycle in order to protect the NHS”.

Finally, the trial by media potentially impacted on the UK government’s formal response in the NFS. Officially, the UK government that had commissioned the NFS had promised to formally respond to the Strategy in a White Paper within 6 months of its release. However, the response to NFS was delayed by five months. When the White Paper was finally released on 13th June 2022, it did not address 13 of the proposed 14 recommendations and was met by disappointment and criticism from public health experts and organisations (Horton and Walker, 2022; Walker, 2022). In particular, the White Paper evaded discussion on the sugar and salt reformulation tax and instead suggested that the responsibility lies with individual consumers. The only recommendation that was addressed in the White Paper was a previous government commitment to Fund The Holiday Activities and Food Programme (Thompson, 2022). Stakeholder response to the White Paper highlighted the lack of legal commitments to reform UK’s food system as recommended in the NFS (George, 2022).

Conclusion

The media framing of the NFS, in particular the negative scaremongering surrounding the sugar and salt tax and the criticism of state intervention to solve the structural causes of food system inequalities, made it acceptable for the government to not only delay its response but also publish a weak and non-committal response to the recommendations. A recent report revealed that every UK government of the past 30 years has failed to tackle the obesity crisis due to fear of “nanny state-ism”. The report highlights how “Politicians are afraid of interfering unduly in people’s choices, especially their diets” (Institute for Government, 2023) and prefer to emphasise individual responsibility rather than systemic interventions. This narrative has been a recurring theme in the media reactions to the NFS, particularly from right-leaning media groups and free market think tanks.

This paper contributes to the existing debates on food systems transformation that stresses the need for structural solutions instead of technofixes that are aimed merely at the consumers. This requires reframing “what we eat” from issue of consumer choice to a wider transformation of the broken food system. As such, the re-politicisation of nutrition and food security as a structural problem that contests the nature of what is produced and how it is distributed (Patel *et al.*, 2015) is essential for policymakers to view the food system transformation as part of a wider social justice process (Hambloch *et al.*, 2023).

The media coverage of NFS has supported the government’s stance of not acting and relying on the invisible hand of the market to fix the food system. Despite the resistance to act shaped by British media, it is imperative that the UK government takes urgent action to address the sustainability challenges present in the food system by carefully reconsidering the evidence-based recommendations proposed by the NFS. Findings from this paper highlight the critical role media

play in acceptance of public policy by setting the narrative. The British media can support progressive food systems transformation by centring the voices of people and holding the government accountable by critically analysing the causes of their policy inertia. roll-out of post-Brexit policies such as Environmental Land Management Scheme and Sustainable farming Incentive, the media should play the important role of showcasing a diversity of views instead of playing the click bate game that polarises public opinions on food systems reform.

Notes

1. A portmanteau of “Britain” and “exit,” Brexit refers to the United Kingdom’s decision to leave the European Union (EU), officially enacted on January 31, 2020, with significant impacts on trade, governance and policy, including food standards and agricultural trade discussed in the context of the National Food Strategy.
2. Marcus Rashford is a well-known English professional footballer who gained prominence for his advocacy on child poverty and food-related issues in the UK.

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S1. Political Stance of Publishers (Source: Authors work)

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Table A1.
Newspaper
classifications and
political stance (from
Yau *et al.*, 2021)

	Category	Description
ABC classification	Popular	Tabloid newspapers aimed at a wide circulation
	Mid-market	Newspapers that are perceived as less populist than popular newspapers but smaller in format than broadsheet newspapers
	Quality	Newspapers that were traditionally broadsheet and are perceived as high quality
Political stance	Left	Political ideology that is described as progressive and tends to favour social equality
	Centre	Political ideology that lies near the centre of the political spectrum
	Right	Political ideology that is described as traditional and tends to favour liberty

S2. Methods for Framing Analysis (Source: Authors work)

To assess the stakeholder groups captured by traditional media, a stakeholder list was collated during the full text eligibility assessment. The content of the included articles was analysed and thematically coded. A priori codes, i.e. codes developed before examining the data, were based on the 14 NFS recommendations and other aspects of interest for this study, including trade deals, EU CAP, new UK CAP replacement policy, BREXIT, livestock production, meat alternatives and meat tax. Articles that discussed any of these themes were labelled and overall comments given. The sentiment of each article towards the NFS was then annotated with each being assigned “positive”, “negative”, “mixed” or “neutral” labels by KB and MT. Articles that were overall supportive/critical towards the NFS were labelled “positive”/ “negative” respectively. Articles that expressed no overall attitude towards the NFS were labelled “neutral”. Articles that presented both supportive and critical comments (e.g. from different stakeholders or different sentiment towards different aspects of the NFS) were labelled “mixed”. This stage of the thematic and sentiment analyses was conducted using Microsoft Excel. The article text was then analysed in NVivo 12 to identify emerging *a posteriori* codes, i.e. codes developed after analysing the text, and to identify key quotes relating to each theme. This process involved auto-coding themes and conducting a word frequency search, and then reviewing and grouping these into overarching themes and sub-themes.

S3. Search String Queries for Twitter API (Source: Authors work)

Query = ““(farming OR farm OR farms OR livestock OR animal OR animals OR agriculture OR agricultural OR agribusiness OR agroecology OR agronomy OR dairy OR cattle OR beef OR sheep OR lamb OR chicken OR chickens OR poultry) (trade OR Brexit OR #Brexit OR #BrexitBritain) -is:retweet (place_country:GB) lang:en”

Query = ““(farming OR farm OR farms OR livestock OR animal OR animals OR agriculture OR agricultural OR agribusiness OR agroecology OR agronomy OR dairy OR cattle OR beef OR sheep OR lamb OR chicken OR chickens OR poultry) (#NationalFoodStrategy OR #FoodStrategy OR (Food Strategy) OR #FoodWhitePaper OR (White Paper) OR #FoodPolicy OR (food policy) OR #AgricultureBill OR (Agriculture Bill) OR (Common Agricultural Policy) OR #EUcap OR (EU Cap) OR #CapReform OR (Cap Reform) OR #BasicPayment OR (Basic Payment) OR #AgriculturalPolicy OR (Agricultural Policy) OR #AgricultureAct OR (Agriculture Act) OR #ELMs OR #ELM OR #EnvironmentalLandManagement OR (Environmental Land Management Scheme) OR #SustainableFarmingIncentive OR (Sustainable Farming Incentive) OR #LocalNatureRecovery OR (Local Nature Recovery) OR #LandscapeRecovery OR (Landscape Recovery) OR #SustainableFarmingScheme OR (sustainable farming scheme) OR #FoodBill OR (food bill) OR #GoodFoodNation OR (good food nation) -is:retweet (place_country:GB) lang:en”

S4. Twitter Thematic Analysis (Source: Authors work)

Tweets were assigned into at least one of the following *a priori* codes (see S4 for details): Brexit, Trade, Animal welfare, Common Agricultural Policy, Environmental Land Management Scheme (ELMS), Sustainable farming incentive, Local Nature Recovery, Landscape Recovery, National Food Strategy, Food white paper, England, Wales, Scotland and Ireland. The content of the tweets was searched for based on a set of keywords and then manually screened for relevance to the theme. The stakeholders were defined to derive understanding of the public perception of different subgroups, and the themes were developed to reflect livestock farming policy changes in the context of the NFS, trade and Brexit based on *a priori* codes. The supplementary material contains the further details of the methodology.

The word cloud, in particular, depicts the language usage frequency, which improves the interpretability of “positive”, “neutral” and “negative” sentiments classified by the machine learning technique (Zhang *et al.*, 2018). The colours indicate sentiment: green for positive, red for negative and grey for neutral/balanced (both positive and negative). However, the wordcloud does not include any positive phrases due to the limited number of them. The phrase size corresponds to its frequency (ranging from minimum of $n = 11$ for “distance transport” to maximum of $n = 106$ for “trade deal”). Due to the small sample size for specific stakeholder groups (the largest stakeholder group among these is “politicians” with 66 tweets from 37 unique users) we primarily analyse the sentiments of the general public.

Theme	Keyword search terms
Brexit	“Brexit”
Trade	“Trade”, “FTA”
Animal welfare	“Welfare”, “rspca”, “cruelty” Excl. “Welfare state”
Common Agricultural Policy	“Common Agricultural Policy”, “#EUCap”, “Eu Cap”, “#CapReform”, “Cap reform”, “Basic Payment”, “#BasicPayment”, “cap”
Environmental land management scheme	“Environmental land management”, “ELM”
Sustainable farming incentive	“Sustainable farming incentive”, “SFI”
Local Nature Recovery	“Local Nature Recovery”, “LocalNatureRecovery”
Landscape recovery	“Landscape Recovery”, “LandscapeRecovery”
National Food Strategy	“Food strategy”, “oodStrategy”, “NationalFoodStrategy”, “NFS”, “food_strategy”, “White paper”, “FoodWhitePaper”
England	“England”, “English”
Wales	“Wales”, “Welsh”, “WelshGovernment”, “WelshConserv”, “sellwelshlamb”
Scotland	“Scotland”, “Scottish”, “ScotTories”, “scotgov”, “heraldscotland”, “BBCScotWeather”, “BBCScotlandNews”
Ireland	“Ireland”, “Irish”
Northern Ireland	“northern Ireland”, “NorthernIreland”, “NIreland”, “NI”, “northern Irish”
Australia and New Zealand	“Aus”, “Oz”, “NZ” Excl. “Wizard of oz”

Source(s): Authors work

Table A2.
Keyword search terms
used in the thematic
coding process

Stakeholder category	Keyword search terms
Politician	“MP”, “MEP”, “MSP”, “TD”, “Parliament”, “Cllr”, “Councillor”, “MLA”, “peer”, “minister”, “Cllrwdp”
Media	“Editor”, “Journalist”, “Journo”, “Broadcaster”, “broadcasting”, “Producer”, “Reporter”, “columnist”, “radio”, “Ongolo”, “Newry”, “BBCCWR”, “BritishHeraldUK”, “itcnews”
Academic	“university”, “academic”, “PhD”, “Dr”, “Prof”, “professor”, “lecture”, “lecturer”, “lect”, “fellow” Excl. “Student”, “dr/bc”
Stakeholder group/ representative	[NFU”, “NFUTweets”, “FarmersWeekly”, “agriuk”, “BeaverTrust” “RiverActionUK”, “oxfordfarming”, “UKSustain” “wwf”, “Nuffield15”, “Nuffield”, “DefraGovUK”, “DefraDigital”, “DevonWildlife”, “ediblebristol”, “foodanddrinkNE”, “PermacultureScotland”, “savillsruraluk”, “ConcaveSummit”, “riveractionUK”, “unhappynewham”, “HartingtonKings”, “CEEBillOxford”, “Eco_NI”, “GreensofColour”, “IanChatfield”, “RSPCA”, “fourpawsint”, “soilfit”, “walesape”, “NatureTherapyCo”, “StoddartsBeef”, “worldresources”, “agrichatuk”, “VLandMovement”, “britishvets”, “FriendsOfTheEarth”, “OpenInnovates”, “SmallholdersUK”, “RSPB”, “Myserscough Farm”, “UNESCO Biosphere”, “FRome Livestock Market”] OR [“director”, “chief”, “executive”, “CEO”, “advisor”, “adviser”, “advisory”, “chair”, “governor”, “commissioner”, “manager”, “ministry”, “policy”, “advisor”, “vicar”, “lead member”, “trust” AND “agri”, “agriculture”, “agricultural”, “livestock”, “farming”, “farm”, “farms”, “rural”, “land”, “wildlife”, “climate”, “environment”, “environmental”, “environmentalist”, “animal”, “animals” “fracking”, “countryside”, “sustainable”, “sustainability”, “food”, “CofE”, “marine”, “woodland”, “wetland”, “conservation”, “ecosystems”, “rewilding”] “activist”, “activists”, “activism”, “environmentalist”, “campaigner”, “campaign”, “campaigns”, “advocate” AND “agri”, “agriculture”, “agricultural”, “livestock”, “farming”, “farm”, “farms”, “rural”, “land”, “wildlife”, “climate”, “environment”, “environmental”, “environmentalist”, “animal”, “animals” “fracking”, “countryside”, “sustainable”, “sustainability”, “food”, “CofE”, “marine”, “woodland”, “wetland”, “conservation”, “ecosystems”, “rewilding” “Farm”, “Farms”, “Farmer”, “Farmers”, “Farming”
Farmer	Any other user without a stakeholder category identified
General public	
Source(s): Authors work	

Table A3.
Keyword search terms
used in the stakeholder
categorisation process

Stakeholder category	Definition
Stakeholder Groups and Representatives	Stakeholder group is defined as an organisation that is linked to food systems, the environment and farming in any way. Representatives include those who mention working with, volunteering or campaigning for a related cause or industry
Politicians	Those who are a member of the UK/Scottish/Irish/European parliament, Legislative Assembly, House of Lords, or are a local councillor
Media	Editors, journalists, columnists, broadcasters, producers, reporters or radio presenters
Experts	Those from any disciplinary background who work for a university, are a doctor, professor, lecturer, fellow or PhD candidate – no other students are included
Farmers and farm workers	Anyone who works on a farm in any capacity
Other/General Public	Any user who does not fall into any other category
Source(s): Authors work	

Table A4.
Definition of
stakeholder categories

S5. Machine Learning Methodology (Source: Authors work)

The fetched tweets were first classified into relevant and irrelevant using a support vector machine (SVM) algorithm. We tagged 480 tweets (212 irrelevant, 268 relevant) that were divided into training (80%) and testing (20%) sets. The text in the tweets were tokenized before training the algorithm. The process of tokenization (reduction of words to its radical and transformation of radicals in numbers) is preceded by a spell-checker algorithm to reduce noise from misspelling. The SVM categorized 1259 tweets as relevant and 812 as irrelevant. The algorithm obtained accuracy of 83.65%, f1-score of 71.91%, accuracy of 73.96%, precision of 71.11% and recall of 72.72%. After removing the irrelevant tweets, we proceeded with the tagging and sentiment analysis of the remaining tweets.

We analysed the sentiment in the tweets creating a sequential long short-term memory (LSTM) machine learning model based on a sample of manually-classified tweets. Figure A1 shows the model structure. The embedding layer is fed with a zero-padded sequence of tokenized words. The two bidirectional layers are followed by a dropout (exclusion of internal data) of 20%. Dropout is adopted to avoid overfitting of the model in training data, which can decrease performance in real data. Finally, the rectified linear unit layer (ReLU) condenses the partial results and translates them in three categories using a softmax function: 0 (negative sentiment), 1 (neutral sentiment) and 2 (positive sentiment).

```
Model: "sequential"
```

Layer (type)	Output Shape	Param #
Emb (Embedding)	(None, 50, 100)	106100
bidirectional (Bidirectional)	(None, 50, 256)	234496
drop20_1 (Dropout)	(None, 50, 256)	0
bidirectional_1 (Bidirectional)	(None, 256)	394240
drop20_3 (Dropout)	(None, 256)	0
relu (Dense)	(None, 64)	16448
st (Dense)	(None, 3)	195

```

=====
Total params: 751,479
Trainable params: 751,479
Non-trainable params: 0
=====

```

Note(s): Machine learning model structure generated using the tensorflow library in Python. Embedding reshape the input to fit the machine learning structure, bidirectional layers are long short-term memory (LSTM) layers, dropout layers remove randomly 20% of the data obtained in the previous layer, “relu” are rectified linear units that condense information from previous layers and “st” stands for softmax function, which translates the linear results to the three categories of interest: positive, neutral and negative sentiment

Source(s): Authors work

Figure A1. Machine learning model structure

From the 190 tagged samples (139 negative, 30 neutral and 11 positive sentiment), we subsampled to balance the proportions as unbalance could cause a decrease in accuracy by ignoring rarer samples (positive sentiments). Hence, the training and testing data were composed of tweets of negative, neutral and positive sentiment in the amounts: 25, 20 and 7 (training), 37, 10, 7 (testing). The precision of the trained algorithm, along with the evolution of accuracy and loss, can be seen in Figure A2. The training was idealized to run with 6000 epochs (random sub-resampling of the training set) with a stop trigger that is activate if the test loss increases for 10 consecutive epochs. As shown in Figure A2, this criteria were met after about 500 epochs.

	precision	recall	f1-score	support	
	0.0	0.85	0.78	0.82	37
	1.0	0.40	0.40	0.40	10
	2.0	0.60	0.86	0.71	7
accuracy				0.72	54
macro avg	0.62	0.68	0.64		54
weighted avg	0.74	0.72	0.73		54

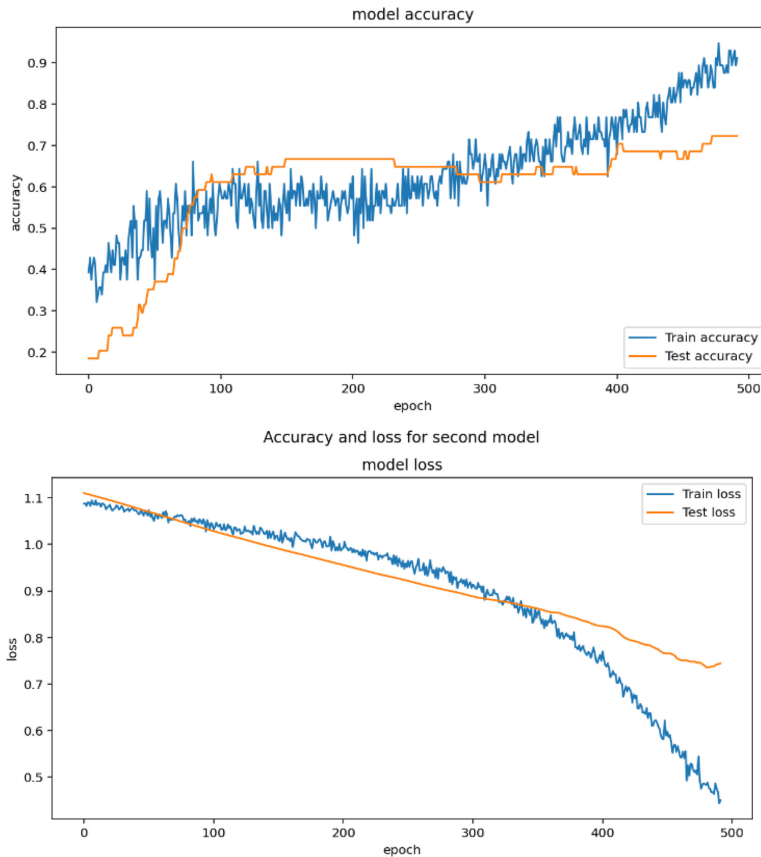


Figure A2.
Results of model
training

Note(s): The test (orange) and training (blue) accuracy and loss is measured through the epochs. Although the model was set to run 6000 epochs, the stop criteria was triggered after about 500 epochs

Source(s): Authors work