Received: 15 March 2023 | Revised: 8 May 2023 | Accepted: 24 May 2023

DOI: 10.1002/vetr.3166

Vet Record

ORIGINAL RESEARCH

Social research to understand farmer and agricultural stakeholder attitudes towards bovine tuberculosis vaccination of cattle

Damian Maye[1] | **Charlotte-Anne Chivers**[1] | **Gareth Enticott**[2] | **Théo Lenormand**[1] | **Sarah Tomlinson**[3]

[1]Countryside and Community Research Institute, University of Gloucestershire, Cheltenham, UK

[2]School of Geography and Planning, Cardiff University, Cardiff, UK

[3]Kingshay, Glastonbury, UK

Correspondence
Damian Maye, Countryside and Community Research Institute, University of Gloucestershire, Cheltenham, UK.
Email: dmaye@glos.ac.uk

Funding information
Defra; Welsh Government; Scottish Government, Grant/Award Number: SE3336

Abstract

Background: This social research study employed a behavioural insights framework, Easy, Attractive, Social, Timely ('EAST'), to identify cues that may influence farmer and stakeholder attitudes towards the deployment of CattleBCG vaccine.

Methods: The EAST framework was employed to develop policy scenarios consisting of several cues likely to affect vaccine uptake. These scenarios consisted of a government-led approach, an individual farmer-led approach, and a third approach, also farmer-led but organised collectively. The government approach was mandatory, while the farmer-led approaches were both voluntary. The scenarios were tested during farmer participatory workshops ($n = 8$) and stakeholder interviews ($n = 35$).

Results: Overall, the EAST framework provided a useful approach for gathering behavioural insights around attitudes towards cattle vaccination. We found an overall receptiveness towards the idea of vaccinating cattle against bovine tuberculosis, particularly where clear, transparent messaging around the likely efficacy is mobilised, where clarity around potential implications for trading is provided, and where vaccine doses are provided free of charge and administered by veterinarians and veterinary technicians. In general, these factors were a pre-requisite to a mandatory (government-led) national approach, which was the preferred deployment mechanism among farmers and stakeholders. However, these conditions would also likely facilitate a voluntary vaccination programme.

Limitations: Trust in those involved in delivering a vaccine programme and trust in the vaccine itself represent a crucial aspect of farmer and stakeholder attitudes towards cattle vaccination; however, this aspect was not covered by the EAST framework.

Conclusion: EAST provided a novel framework for examining attitudes towards cattle vaccination with CattleBCG, although we recommend incorporating a 'trust' component in future iterations.

INTRODUCTION

Bovine tuberculosis (hereafter 'bTB') remains one of the most challenging animal diseases in the UK, costing UK taxpayers over £150 million each year.[1] While significant attention has been directed towards the role of badger culling in reducing bTB incidence, the use of a cattle vaccine has the potential to be a 'game-changer'.[1,2] In 2020, a review of Defra's bTB strategy concluded that a cattle vaccine was a top priority.[3] Field trials to test the safety and efficacy of the use of the bacille Calmette-Guérin (BCG) vaccine in cattle began in 2021, with the aim of securing national marketing authorisations for the vaccine and a new skin test to differentiate infected cattle from vaccinated cattle. However, encouraging the use of a vaccine at scale will likely depend on a range of factors, including efficacy, economic and social factors (such as willingness to pay)[4] and trust in vaccines.[5,6] Recognising these socio-economic barriers to vaccine

deployment, Godfray and others called for greater social research into farmers' attitudes towards vaccination (for a link to the 2018 strategy review and the government's response see[3]). Similarly, the British Veterinary Association's recent policy on bTB emphasises the need for bTB policy to understand farmers' behaviour and incorporate 'behavioural insights' to help eradicate bTB.[2] This paper addresses both of these concerns by seeking to examine farmer and agricultural stakeholder attitudes towards vaccinating cattle with CattleBCG. It does so by utilising a behavioural insights framework called Easy, Attractive, Social, Timely[7] ('EAST') to identify the likely behavioural factors that will influence the acceptance and uptake of a cattle vaccine.

MATERIALS AND METHODS

To capture meaningful understandings of farmers' and stakeholders' attitudes towards cattle vaccination, a methodological approach was required that could capture views on vaccines that: (a) do not currently exist; (b) have limited/no evidence that they reduce bTB incidence; and (c) are sensitive to the political dimensions of bTB, including those surrounding badger culling. To address these methodological challenges, the study relied on the use of the EAST behavioural insights framework and scenario analysis, as described below.

The EAST behavioural insights framework

Behavioural insights reflect a form of psychological governance that seeks to alter human behaviour without direct regulation. The concept stems from work in behavioural economics that seeks to 'nudge' individuals towards the 'right' choices and in doing so benefit populations.[8] While public health campaigns have traditionally relied upon educating people through information campaigns, behavioural insights approaches identify how specific behavioural cues and biases can affect decision making.

A range of different behavioural insight frameworks have been used to shape human behaviour in human and veterinary medicine.[9,10] Each of these frameworks shares a common set of behavioural influences that are reflected in the EAST behavioural insights framework.[7] This framework suggests that behaviour can be influenced by making behavioural choices easy, attractive, social and timely (see Table 1). Conversely, Thaler[11] refers to the opposite of these influences as behavioural 'sludge': making things difficult, for example, acts as a behavioural friction that reduces the chances of taking the optimum or desirable choices.

Scenario development

CattleBCG vaccine is currently undergoing UK field trials. Understanding farmers' motivations to use an unapproved technology can, therefore, only be hypothetical. However, waiting until the vaccine receives marketing authorisation will likely be too late, particularly if a roll-out is mobilised quickly. One approach that seeks to bridge this gap is scenario methodologies. Scenarios represent a plausible description of an alternative future that can be used to stimulate thinking or challenge preconceptions.[13] They are particularly useful in eliciting attitudes and beliefs about complex and potentially sensitive situations[14,15] and in examining the causes and consequences of what may happen in the future.[16] The use of scenarios can serve four purposes: making sense of puzzling situations, developing strategy, anticipation and adaptive organisational learning, all of which apply to unknown vaccination policies. In health psychology, scenarios take the form of textual or visual vignettes[17] to describe and elicit attitudes and beliefs towards a specific situation.[18] For scenarios to be effective, they need to be carefully designed to capture the reality of people's lives[19] and ensure their generalisability.[17] In animal health and disease research, these scenario methods have been used to identify influential advisors[20] and factors affecting the disclosure of a new disease outbreak.[21]

Research tools

Informed by existing literature and with the help of bTB policy makers in England, Wales and Scotland, veterinarians and vaccine scientists, three scenarios representing possible policy mechanisms for the deployment of CattleBCG vaccination were developed. Each scenario was designed to incorporate specific behavioural insights. Each scenario reflected a different model of delivery, termed 'individual responsibility', 'state responsibility' and 'collective responsibility'. These policy scenarios were realistic because they reflected existing animal disease policy approaches, while the focus on how vaccination could take place and who should deliver it reflected existing concerns about trust in bTB science and vaccines.[5,20] The three scenarios and the key EAST behavioural cues associated with them are summarised in Table 2.

As shown in Table 2, all three scenarios included cues that were (un)attractive, easy/difficult, social/unsocial and (un)timely. Scenario 1 was a voluntary approach in which farmers decided whether to vaccinate, scenario 2 was a government-led mandatory approach, with vaccination organised by the government, and finally, scenario 3 required vaccination to be delivered through farmer-run vaccination companies. All three scenarios were realistic in that they each reflected either farmers' existing use of vaccines or elements of the bTB control programme. For example, in England, farmers have established farmer-run disease control companies to manage transmission threats from badgers. Some information was kept consistent across the three scenarios, reflecting scientific advice. The vaccine efficacy in all three scenarios was 85%, based on existing studies.[22] All scenarios also included a 90-day meat withdrawal period (i.e., the minimum

TABLE 1 Description of the Easy, Attractive, Social, Timely (EAST) framework attributes in the context of cattle vaccination

EAST component	Description
Easy	Policies and practices that are easy to use are more likely to be adopted. This includes changing default settings to make signing up to a national vaccination scheme as easy as possible.
Attractive	Policies and practices that are attractive are more likely to result in uptake. For a vaccination programme, this may include the use of financial or other incentives to reward good behaviours or penalise inappropriate ones.
Social	People are more likely to adopt a policy or practice if they know that other people in their social or geographical group are also following it. This is particularly relevant in agriculture where studies have shown that social norms play an important role in farmer decision making.[12] For a vaccination programme, this component expects that general uptake will increase when farmers can see that their peers have already adopted it.
Timely	Where new policies are introduced at appropriate times, they are more likely to be accepted. For a vaccination programme, this might include timing interventions in relation to the seasonality of farming and associated work demands.

TABLE 2 Policy scenarios used as part of an examination into the extent to which each Easy, Attractive, Social, Timely (EAST) component is useful for examining farmer and stakeholder attitudes towards vaccinating cattle with the bacille Calmette-Guérin (BCG) vaccine

	Policy scenario behavioural cues		
EAST components	**Individual responsibility**	**State responsibility**	**Collective responsibility**
Easy/difficult	Voluntary approach	Mandatory approach	Voluntary approach
	National roll-out	Roll-out in priority areas	National roll-out
Attractive/unattractive	Farmer pays £6/head for doses	Vaccination is free	Farmer pays £6/head for doses
	Farmers administer the vaccine	APHA coordinate and deliver the vaccines	Vaccination companies coordinate and deliver vaccines
	Slow process/yearly booster needed	Failure to vaccinate becomes a criminal offense	80% sign-up is required
	No penalties for not taking part	No compensation for unvaccinated herds	No penalties for not taking part
		85% efficacy	
		90-day meat withdrawal	
Social/unsocial	Individually-led	Government-led	Group-led
Timely/untimely	Vaccination can be carried out when convenient for the farmer (in cattle over 8 weeks of age)	Farmers are given a 3-month window to complete vaccinations	Farmer's own veterinarian and local farming union is involved

time between an animal's last dose and permitted entry of its meat or offal into the food chain). This was included to reflect CattleBCG's draft summary of product characteristics for the Animal Test Certificate permitting the field trials[23] but also to introduce behavioural frictions to vaccination.

Data collection

Attitudes towards the scenarios were explored through a series of 2-hour participatory farmer workshops (n = 8, Table 3) and 1-hour interviews with industry stakeholders (n = 35). For each scenario, a full written statement was read out by the workshop facilitator or interviewer and accompanied by a visual aid consisting of illustrations representing each key behavioural cue for a given scenario, thus acting as a prompt. Full ethical approval was gained from the ethics committee at the University of Gloucestershire prior to data collection.

TABLE 3 Cattle vaccination farmer workshops

Location	bTB status	Participant numbers
Bakewell, Derbyshire	Edge area	10
Frome, Somerset	High-risk area	16
Louth, Lincolnshire	Low-risk area	12
Whitchurch, Shropshire	High-risk area	13
Pembrokeshire, SW Wales	High TB area	25
Ruthin, NE Wales	Intermediate TB area	6

Abbreviations: bTB, bovine tuberculosis; TB, tuberculosis.

Farmer workshops

The farmer workshops were carried out by the entire research team between March and April 2022 within different bTB risk areas across England and Wales (Table 3). Workshop participants were recruited through existing networks known to the research team and the bTB partnership, enabling good access to local

farmer networks. Workshop flyers were also shared on social media and via local cattle industry contacts. The workshops were organised at venues known and trusted by the local farming community, for example, livestock markets, and lasted for 2–2.5 hours each. The majority of workshop participants (83%) stated that they already administered at least one type of vaccine. In terms of sample characteristics of workshop participants, all were actively involved in cattle farming, with half involved in dairy farming to some degree (40% were exclusively dairy farmers), with other participants identifying as dairy and beef (17%), beef stores (22%) or finishers (17%). The majority of workshop participants (78%) reported having had at least one bTB breakdown on their farms. Most farmer workshop participants (71%) buy cattle less than yearly, with several (31%) never buying cattle. This lack of buying in cattle indicates a high level of on-farm breeding and finishing, in part a strategy to reduce bTB risk by not buying in cattle from outside the farm. Meanwhile, most participants (69%) sell cattle at least once a year.

Semi-structured interviews

Semi-structured interviews (n = 35) were completed by C. A. C., T. L., G. E. and D. M. between April and June 2022 with a range of cattle industry stakeholders, including national and local farming organisation representatives (n = 7 and 8, respectively), veterinarians (n = 6), auctioneers (n = 5), pedigree breeders (n = 2), representatives from regulation, assurance and advice bodies (n = 5), a supermarket (n = 1) and a trading body (n = 1) representative. The interview sample was purposive, with participants recruited by identifying a list of stakeholder types needed to reflect cattle industry and trade perspectives. The research team then used a combination of known contacts in the sector, combined with internet searches, snowballing and introductions from policy or industry contacts. Most interviews lasted 1 hour (ranging from 20 to 90 minutes) and were held in-person (n = 12) or online using Zoom (n = 23).

Data analysis

The workshops and interviews resulted in a total of 42 hours of audio recordings (12 hours from the workshops and 30 hours from the interviews). These recordings were transcribed verbatim and analysed using NVivo 12 Plus by CAC and TL. Thematic analysis was then carried out, whereby the qualitative data were categorised into key themes relating to vaccination using a pre-constructed codebook based around the EAST constructs. As analysis continued, additional codes were added inductively based on the content of the quotes. This resulted in a highly detailed qualitative dataset; workshop coding alone resulted in 3758 data points. Upon coding the qualitative data, the researchers were better able to identify key narratives emerging from the interviews and workshops.

TABLE 4 Summary of key findings regarding factors likely to increase farmer uptake of cattle vaccination against bovine tuberculosis (bTB), including levels of agreement shown by farmer and stakeholder participants

Factors likely to encourage uptake of cattle vaccines against bTB	Level of agreement between participants
Clarity around the efficacy of the BCG vaccine and DIVA testing	High
Information around potential consequences for trading	High
Vaccination roll-out has been co-designed with the farming community	High
Regular engagement with APHA/Defra	High
Cattle vaccination should be mandatory to achieve bTB control	High
Deployment of the cattle vaccination should be national	Medium–high
Vaccination timings should be flexible	High
A need to control other vectors of bTB simultaneously	Medium
Meat withdrawals should be less than 90 days	High

Abbreviation: APHA, Animal and Plant Health Agency; BCG, Bacille Calmette-Guérin; DIVA, detecting infected among vaccinated animals.

RESULTS

Overall, farmers and stakeholder participants were broadly supportive of cattle vaccination. Many farmers expressed hope that vaccination would make a significant contribution to reducing bTB, particularly those who had experienced multiple long-term bTB incidents. There was recognition, however, that the complexity of controlling livestock disease and different farming systems meant that vaccination might not be a 'silver bullet' but one element of the eradication strategy. Of the three policy scenarios, the government-led, mandatory approach was the most popular, while the vaccination company scenario was the least popular. Subsequent sections analyse how the EAST behavioural cues affected farmer and stakeholder participant scenario preferences. Table 4 provides an overview of the main findings and the level of agreement between farmer and agricultural industry stakeholder participants.

Making things 'easy' for cattle vaccination acceptance

Mandatory approaches to cattle bTB vaccination reflect a default setting. This approach is 'easy' because farmers are automatically enrolled in a vaccination campaign, similar to the existing policy used

to increase organ donation. Farmer and stakeholder responses to these behavioural cues were nuanced, but we found a high level of support for making vaccination a default overall. Participants argued that the default approach was likely to be 'easiest' in terms of take-up because farmers would not have to organise it themselves; instead, it would be mandatory and arranged for them (see Supporting Information, quotes 1–3). Although this default setting was not universally supported, overall, there was strong support for this way of organising cattle vaccination. Cattle vaccination for bTB required an approach to delivery and recording that was essentially, participants felt, the responsibility of government. In contrast, participants recognised that a voluntary approach may not result in sufficient take-up, resulting in continued bTB incidences and thus making bTB control difficult.

It was anticipated that some farmers may see keeping vaccination records as an additional level of bureaucracy, making it 'difficult'. However, participants found the idea of keeping records via livestock passports, iBTB (an interactive mapping tool displaying ongoing and resolved bTB outbreaks in England and Wales), the Livestock Information System or the Cattle Tracing System relatively easy, largely as they already do so for other routine vaccinations. Some suggested that vaccination status could be recorded on ear tags. Workshop participants and interviewees did, however, highlight potential trade barriers due to vaccination, calling for a recording and communication process that was easy to navigate and clear in terms of communicating vaccine status.

Making things 'attractive' for cattle vaccination acceptance

The attractiveness of bTB cattle vaccination was expressed in the scenarios in different ways. One way this was assessed was vaccine efficacy, set at 85% for all three scenarios. Overall, this figure was broadly acceptable to workshop and interview participants, but with some exceptions. Some farmers argued that efficacy needed to be closer to 100% and that they would need to see robust evidence that the vaccine worked. On the other hand, other farmers who had experienced multiple bTB breakdowns argued that an efficacy of 50% and lower would still be worthwhile if it meant one fewer cow was lost to bTB. In one workshop, farmers expressed attractiveness in terms of reducing the number of reactors in a breakdown. If it was possible to reduce reactor numbers by half, this would be acceptable. Moreover, participants stated that in addition to having trust in the vaccine itself, they would also need to trust that the detecting infected among vaccinated animals (DIVA) test will not result in false positives. Overall, it appears that clear, trusted communication around the efficacy of both the vaccine itself and of DIVA testing is key (see Supporting Information, quotes 4–6).

A second proxy for attractiveness was the idea of a zero or low-cost vaccine for farmers. Participants supported the idea of a low-cost vaccine (see Supporting Information, quotes 7 and 8). The figure of £6 per dose was not seen as a barrier in general, provided that vaccinating was voluntary. For some farmers, the idea of vaccinating cattle and moving towards bTB control was attractive regardless of cost. This was not a universal view expressed in the workshops, but reflects the desperation from farmers to find a solution, particularly those under repeat movement restrictions. That said, there was consensus that making farmers pay directly for vaccination under a mandatory programme would be unattractive. Other participants argued that if they are to continue undertaking bTB testing on a regular basis, which is costly due to labour requirements, then they should not be expected to pay towards cattle vaccination.

Penalties and rewards—expressed in terms of additional compensation for farmers that vaccinated, or none for farmers that did not—were also used to explore attractiveness. Views on this were mixed (see Supporting Information, quotes 9 and 10). Farmer participants who were already in support of cattle vaccination argued that unvaccinated cattle should no longer be eligible for compensation as this would encourage uptake among less engaged farmers. However, participants tended to find a reward-based system approach more attractive. A reduced need to test for bTB upon vaccination would also act as an attractive incentive for encouraging vaccination uptake, as this would reduce stress and time burdens (see Supporting Information, quote 11). This was a view expressed in all five farmer workshops.

Attractiveness of vaccination was also explored in relation to trade. The 90-day meat withdrawal was highly unattractive to participants due to concerns that it could have significant repercussions for cattle trading and herd management (see Supporting Information, quotes 12 and 13). For farmers, it would make it difficult to split up and manage different groups of cattle, for example, affecting their flexibility to manage their stock, as well as additional pressures on infrastructure to house split groups of cattle. Participants were also concerned about differing strategies across the devolved nations, resulting in a two-tier market or complexity around trading between England, Wales and Scotland. Participants also shared views around international trading, again largely voicing uncertainty and a need for clarity. For example, stakeholders with experience and knowledge of international trading regulations were adamant that EU countries would not accept DIVA testing or vaccinated cattle, while others voiced EU exit-related concerns. Others were concerned that countries outside the EU would refuse to import vaccinated cattle if it meant the meat was no longer classed as 'bTB free'.

One final aspect of attractiveness that emerged from the workshop and interview discussions was a perceived need for wildlife control in addition to cattle vaccination as part of acceptance and confidence in an overall bTB control strategy. Farmer workshop participants argued, for example, that this aspect of bTB

control should not stop because of cattle vaccination (see Supporting Information, quotes 14 and 15).

Making things 'social' for cattle vaccination acceptance

Behavioural cues to make things social focused on who should organise and conduct cattle vaccination. Participants agreed that farmers should not administer the vaccine themselves, largely due to concerns surrounding accuracy of storage and precision when vaccinating livestock. Instead, veterinarians and veterinary technicians were the preferred vaccinators due to being well-trusted by farmers and able to administer vaccines correctly (see Supporting Information, quotes 16–18). APHA staff were also trusted by participants, although most saw thier participation as unlikely due to a perception that the agency lacks sufficient resourcing to administer such a complex and time-demanding programme.

Participants were firmly against the idea of vaccination being delivered by farmer-led groups established in a similar way to English badger cull companies, largely due to the amount of resources (financial and time spent administering such an intervention) and the levels of stress involved (see Supporting Information, quote 19). Instead, farmers expressed preference for a government-managed roll-out. However, the roll-out of government-led vaccination was caveated by distrust towards the government and policymakers. This reveals a tension between farmers favouring a more regulated approach but nevertheless wary of whether the government can be trusted to deliver the programme. Participants in England and Wales shared several reasons for being distrustful of their respective governments, largely due to a perceived lack of concerted effort to control bTB, a paucity of clear messaging, and a view that policymakers themselves are unaware of the complexity associated with controlling the disease, in part due to recognition of short institutional memories.

Making things 'timely' for cattle vaccination acceptance

Timeliness was expressed in the scenarios in two main ways. First, in terms of the speed by which vaccination was rolled out: at a national level or starting in regions of high incidence before then moving to lower risk areas. Second, the extent to which farmers could choose when to vaccinate their livestock. In relation to the first component, speed of roll-out, farmers supported a rapid universal national roll-out rather than a targeted phased region-by-region roll-out (see Supporting Information, quotes 20 and 21). The rationale for this was partly time-related but also reflected a preference to avoid any risk of creating a two-tier market, combined with a sense of fairness and the desire to make a concerted effort to control bTB as a national priority.

In the workshops and interviews, the second aspect in particular revealed some clear preferences. There was preference for a flexible approach that allowed farmers to fit vaccination in with their operations and farming calendar. In short, the timing of cattle vaccination was critical. Participants stated that they would need to be able to vaccinate at certain times to fit around their existing livestock movements (see Supporting Information, quotes 22 and 23). In the mandatory scenario, for example, a 3-month window for vaccination was seen as too inflexible due to not fitting with existing farm business practices (e.g., trading cycles).

DISCUSSION

Mobilising the EAST framework allowed this research to gather important insights into farmer and stakeholder attitudes towards vaccination of cattle with CattleBCG. Examining the EAST-oriented behavioural cues across all three scenarios, key positive cues likely to encourage vaccine uptake include free deployment of the vaccine (with private veterinary surgeons seen as the most trusted to administer doses), clear messaging around vaccine efficacy, a reduced requirement to test for bTB, compensation as an incentive and minimal implications for trade. While participants stated that these factors would be important for a voluntary vaccination programme, a default setting of a national mandatory scheme was also seen as helpful to maximise the number of participating farmers. Participants suggested that other control measures will be necessary in conjunction with cattle vaccination to achieve bTB control, namely, badger culling alongside on-farm prevention measures (e.g., raising feed troughs). This reflects a view that no single control measure will act as a 'silver bullet' for eradicating the disease. Future research should further explore a scenario that incorporates all of the above cues.

Looking across the scenarios, the research also reveals general acceptance of cattle vaccination as a control mechanism for bTB. This willingness to consider vaccination as a control measure was likely influenced by the existing use of routine vaccinations in livestock enterprises; a study found that 86% of surveyed farmers had vaccinated their cattle in a given year, generally against diseases such as bovine viral diarrhoea, leptospirosis and infectious bovine rhinotracheitis.[24] In addition, there was a sense of desperation among many farmer participants, particularly those who had experienced multiple bTB breakdowns, resulting in further willingness to consider new control measures.

In terms of specific cues, a government-led mandatory approach, while unattractive to some, was generally seen as the easiest and best mechanism for ensuring that any cattle vaccination deployment maximises its potential for achieving bTB control. This contradicts a recent preference for voluntary approaches characterised by 'nudges', with behavioural insights used to make deployment mechanisms more effective

and attractive to farmers based around a recognition of the complex intrinsic and extrinsic factors that affect willingness and uptake.[25–27] While a mandatory approach may be easiest, a voluntary approach under a specific scheme design including several motivational mechanisms (i.e., not just financial) could also result in increased vaccine uptake, as has been suggested with other livestock diseases.[27]

That private veterinary surgeons and other suitably qualified persons (i.e., veterinary technicians) were seen as the 'easiest' option for administering CattleBCG vaccine was unsurprising; veterinarians are routinely advising on the use of and dispensing vaccines. In addition, farmers see their own veterinarians as their most important source of information surrounding vaccination,[28] and they are generally trusted by the farming community.[29,30]

Whether vaccine doses would be offered to farmers free of charge was key for affecting how attractive uptake was. It was unsurprising that farmers were unwilling to pay directly for vaccine doses under a mandatory deployment mechanism; in many jurisdictions, including the UK, mandatory vaccination costs are typically paid for by the government.[28] Research in Canada found that herd size, social acceptability and buyer recommendations had a strong influence on whether farmers would pay for livestock vaccinations.[28] Here, we found that previous encounters with bTB had a strong effect on how unattractive paying towards doses was.

Farmers and stakeholders rejected the idea of a collective mechanism for the deployment of CattleBCG vaccine due to it being seen as too difficult and socially unappetising. In addition, a collective approach has been used to deliver regional badger culls in England; this appears to have had a profound impact on how participants respond to a collective approach due to how time-consuming and stressful organising culls has been.[31] Another study also found that most participants rejected biosecurity-related collective measures, often due to a perception that endemic livestock disease is suffered from by 'bad' farmers.[32] As a result, there was little motivation among these farmers to form groups to tackle problems seen as associated with individuals. Collective action in general surrounding biosecurity for UK cattle is also rare,[32] so farmers may not feel comfortable with this approach due to needing to trust others in their group to vaccinate their cattle effectively.

A key implication for policymakers and the veterinary community relates to the presence of differing levels of understanding among participants surrounding how vaccines work and their realistic efficacy, reiterating a need for clear, transparent communication prior to and during any vaccine deployment. In addition, participants expressed a need for clarity surrounding any potential implications prior to any vaccine deployment. This messaging will allow farmers and stakeholders to prepare accordingly and develop trust in the vaccine.

Our findings also indicate that while farmers and stakeholders are receptive towards the idea of vaccinating cattle against bTB, there is a clear need for clarity surrounding several aspects prior to any deployment. Importantly, any potential trade implications must be addressed and communicated with farmers. While current guidance supports a 90-day meat withdrawal, this was highly unattractive to many participants, particularly beef farmers with a high turnover of livestock. If this withdrawal is unavoidable, this information should be shared widely, with farmers consulted on how they might make this practical on-farm. For example, if they are offered flexibility in terms of timings, the withdrawal period may become less difficult, or if farmers only have to vaccinate breeding stock or grazed livestock.

Using a behavioural insights framework (EAST) to examine attitudes towards cattle vaccination has provided valuable insights into farmer and stakeholder views and the extent to which behavioural cues relating to each EAST construct are likely to affect vaccine uptake. However, we found that EAST does not cover all aspects of farmer decision making, with 'trust' in particular missing from the framework.[33,34] Trust in those involved in delivering a vaccine programme and trust in the vaccine itself represented a crucial aspect of farmer and stakeholder attitudes towards cattle vaccination; thus, in the future, we would iterate the EAST framework to assess whether adding 'trust' as a component provides further insight into likely vaccine uptake. Nevertheless, it provides a novel means to explore what might motivate farmers to use a cattle vaccine to prevent bTB.

AUTHOR CONTRIBUTIONS

All authors contributed substantially to this paper. *Conception and research design, data collection, analysis and interpretation and manuscript drafting and editing*: Damian Maye, Charlotte-Anne Chivers and Gareth Enticott. *Research design, data collection, analysis and interpretation*: Théo Lenormand and Sarah Tomlinson. All authors have approved this final submitted version.

ACKNOWLEDGEMENTS

We are grateful to colleagues from Defra, Welsh Government and Scottish Government who provided guidance and helpful feedback during the research process. We would also like to acknowledge all the farmers and agricultural stakeholders who gave up their time to participate in the study. Finally, thanks to the two anonymous reviewers for their constructive feedback on the manuscript. This work is supported by Defra; Welsh Government; Scottish Government (project number: SE3336).

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to report. Gareth Enticott and Sarah Tomlinson are members of Defra's Bovine Tuberculosis Partnership Board.

DATA AVAILABILITY STATEMENT

Some of the gathered anonymised qualitative data from this study are available in the appended Supporting Information. Other data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

ETHICS STATEMENT

Full ethical approval was gained from the ethics committee at the University of Gloucestershire prior to data collection.

REFERENCES

1. Defra. Bovine tuberculosis in England in 2020. 2020. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1027591/tb-epidemiological-report-2020.pdf. Accessed 24 Feb 2023.
2. British Veterinary Association. Bovine tuberculosis. 2023. Available from: https://www.bva.co.uk/take-action/our-policies/bovine-tuberculosis/. Accessed 24 Feb 23.
3. Defra. A strategy for achieving bovine tuberculosis free status for England: 2018 review—government response [Internet]. 2020. Available from: https://www.gov.uk/government/publications/a-strategy-for-achieving-bovine-tuberculosis-free-status-for-england-2018-review-government-response. Accessed 5 May 2023.
4. Bennett R, Balcombe K. Farmers' willingness to pay for a tuberculosis cattle vaccine. J Agric Econ. 2012;63:408–24.
5. Enticott G, Maye D, Fisher R, Ilbery B, Kirwan J. Badger vaccination: dimensions of trust and confidence in the governance of animal disease. Environ Planning A. 2014;46:2881–97.
6. Maye D, Enticott G, Naylor R, Ilbery B, Kirwan J. Animal disease and narratives of nature: farmers' reactions to the neoliberal governance of bovine tuberculosis. J Rural Studies. 2014;36:401–10.
7. Behavioural Insights. EAST: four simple ways to apply behavioural insights. Behavioural Insights Team. 2014. p. 1–53.
8. Thaler RH, Sunstein CR. Nudge: improving decisions about health, wealth and happiness. Yale University Press; 2008.
9. Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement Sci. 2011;6:42.
10. Mingolla C, van Mol W, Hudders L, Cauberghe V, Claerebout E. Unravelling Belgian Blue cattle farmers' adoption intention towards diagnostic tools: integrating insights from behavioural economics and socio-cognitive theories. Prev Vet Med. 2021;188:105238.
11. Thaler RH. Nudge, not sludge. Science. 2018;361:431.
12. Burton RJF, Forney J, Stock P, Sutherland LA. The good farmer: culture and identity in food and agriculture. London: Routledge; 2020.
13. Quine CP, Barnett J, Dobson ADM, Marcu A, Marzano M, Moseley D, et al. Frameworks for risk communication and disease management: the case of Lyme disease and countryside users. Philos Trans R Soc A. 2011;366:2010–22.
14. Soleri D, Cleveland DA. Scenarios as a tool for eliciting and understanding farmers' biological knowledge. Field Methods. 2005;17:283–301.
15. Hulme M, Dessai S. Negotiating future climates for public policy: a critical assessment of the development of climate scenarios for the UK. Environ Sci Policy. 2008;11:54–70.
16. van der Heijden K. Scenarios: the art of strategic conversation. Chichester: John Wiley & Sons; 2019.
17. Hughes R, Huby M. The application of vignettes in social and nursing research. J Adv Nurs. 2002;37:382–6.
18. de Bruyn S, Wouters E, Ponnet K, Tholen R, Masquillier C, Remmen R, et al. Off-label prescribing of stimulant medication to students: a qualitative study on the general practitioner perspective. Sociol Health Illness. 2020;42:1657–72.
19. Gould D. Using vignettes to collect data for nursing research studies: how valid are the findings? J Clin Nurs. 1996;5:207–12.
20. Maye D, Enticott G, Naylor R. Using scenario-based influence mapping to examine farmers' biosecurity behaviour. Land Use Policy. 2017;66:265–77.
21. Delgado AH, Norby B, Scott HM, Dean W, McIntosh WA, Bush E. Distribution of cow–calf producers' beliefs about reporting cattle with clinical signs of foot-and-mouth disease to a veterinarian before or during a hypothetical outbreak. Prevent Vet Med. 2014;117:505–17.
22. Nugent G, Yockney IJ, Whitford J, Aldwell FE, Buddle BM. Efficacy of oral BCG vaccination in protecting free-ranging cattle from natural infection by *Mycobacterium bovis*. Vet Microbiol. 2017;208:181–9.
23. TBhub. Development of a deployable tuberculosis vaccine for cattle. 2020. Available from: Accessed 12 Jan 2023.https://tbhub.co.uk/resources/frequently-asked-questions/development-of-a-deployable-tuberculosis-vaccine-for-cattle/
24. Cresswell E, Brennan ML, Barkema HW, Wapenaar W. A questionnaire-based survey on the uptake and use of cattle vaccinations in the UK. Vet Rec Open. 2013;1(1):e000042.
25. Benartzi S, Beshears J, Milkman KL, Sunstein CR, Thaler RH, Shankar M, et al. Should governments invest more in nudging? Psychol Sci. 2017;28:1041–55.
26. Hertwig R, Grüne-Yanoff T. Nudging and boosting: steering or empowering good decisions. Perspect Psychol Sci. 2017;12:973–86.
27. Sok J, Fischer EAJ. Farmers' heterogeneous motives, voluntary vaccination and disease spread: an agent-based model. Eur Rev Agric Econ. 2020;47:1201–22.
28. Ugochukwu AI, Phillips PWB. Canadian beef and dairy farmers' attitudes towards animal vaccines. Aust J Agric Resour Econ. 2019;63:814–40.
29. Azbel-Jackson L, Heffernan C, Gunn G, Brownlie J. Exploring the role of voluntary disease schemes on UK farmer bio-security behaviours: findings from the Norfolk–Suffolk bovine viral diarrhoea control scheme. PloS One. 2018;13:e0179877.
30. Hagar C. Whom do you trust? Information seeking during the UK foot and mouth crisis. Libr Arch Security. 2010;23:3–18.
31. Chivers C-A, Maye D, Lenormand T, Enticott G, Tomlinson S. Exploring farmer attitudes towards the vaccination of badgers against bovine tuberculosis. Technical report to Defra. 2022. p. 1–34.
32. Heffernan C, Nielsen L, Thomson K, Gunn G. Exploration of the drivers to biosecurity collective action among a sample of UK cattle and sheep farmers. Prevent Vet Med. 2008;87:358–72.
33. Mankad A. Psychological influences on biosecurity control and farmer decision-making. A review. Agron Sustain Dev. 2016;36:36–40.
34. Rose DC, Keating C, Morris C. Understand how to influence farmers' decision-making behaviour: a social science literature review. Report to AHDB. 2018. p. 1–44.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Maye D, Chivers C-A, Enticott G, Lenormand T, Tomlinson S. Social research to understand farmer and agricultural stakeholder attitudes towards bovine tuberculosis vaccination of cattle. Vet Rec. 2023;e3166. https://doi.org/10.1002/vetr.3166