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Playing games with 'good farming': exploring the potential impact of disease control policies on farmers' cattle purchasing practices

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ABSTRACT

This paper explores how understandings of what constitutes 'good farming' play a significant role in shaping farmers' cattle purchasing decisions. The purchasing of cattle has been shown to be one of the most significant biosecurity risks resulting in disease transmission and translocation. As a result, biosecurity policy makers have sought to develop behavioural interventions to reduce disease risks associated with cattle purchasing. In other policy areas, notions of 'good farming' have been shown to influence farmers' decision-making, and reflect the role of heuristics and social norms in behavioural theory. A scenario-based cattle purchasing game was developed to compare the potential impact of different ways of measuring and visualising 'good farming' to reduce the spread of animal disease (specifically bovine Tuberculosis). Qualitative and quantitative analysis of farmers' purchasing rationales given during the game suggested that cattle purchasing is shaped by a strategy of 'fitting the system' in which cattle are primarily selected on the basis of being able to fit existing farming systems. Symbols of good farming pictured in cattle sales adverts – such as good stockmanship, and cleanliness – were important elements of this strategy. Attempts to quantify aspects of good farming were welcomed but not fully trusted. Good farming status was nevertheless more important than financial incentives when deciding which cattle to purchase. In conclusion, the paper highlights the relevance of these findings for biosecurity policy makers seeking to use behavioural insights to manage animal disease.

1. Introduction

The concept of the 'good farmer' and 'good farming' has been used to explain farmers' resistance towards environmental land-use policies. Various studies (Burton et al., 2008; Cusworth, 2020; Franklin et al., 2021; Huttunen and Peltomaa, 2016; Lastra-Bravo et al., 2015; Wheeler et al., 2018) have described how payment for environmental public goods fails to compensate farmers' loss of cultural identity, articulated visibly to the wider farming community through symbolic capital such as 'tidy' fields and hedgerows. Biosecurity policy makers face a similar challenge. Since the invention of modern disease animal control, financial incentives have been used to encourage participation in disease surveillance schemes and/or compensate farmers whose animals are slaughtered to stamp out disease. Recently, influenced by the 'behavioural turn' in policy making (Jones and Whitehead, 2018), biosecurity policy makers have begun to view withholding or reducing compensation payments alongside other behavioural cues as a way of 'nudging' farmers towards better biosecurity. However, recent research suggests that farmers' biosecurity practices are also influenced by what they consider to be good farming (Enticott et al., 2021) suggesting the need to think more broadly about the kinds of behavioural cues and strategies required to reduce disease incidence.

The purpose of this paper is to explore in greater depth the role that different behavioural interventions have upon farmers' biosecurity decisions. Specifically, we focus on the salience of the symbols and measures of good farming in relation to animal disease, and financial incentives for one biosecurity practice - cattle purchasing – in the management of bovine Tuberculosis (bTB). The movement of livestock from one farm to another, often via a livestock market, is frequently identified as the most significant risk factor in the spread of bTB as well as other exotic and endemic diseases (Carrique-Mas et al., 2008; Johnston et al., 2011; Vial et al., 2015). Disease outbreaks may compromise farmers' ability to publicly demonstrate their good farming statues as governments prohibit the movement of infected livestock. However, the limitations of disease surveillance systems and diagnostic uncertainties, and concerns that regulatory approaches could damage farming

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economies have led biosecurity policy makers to consider behavioural policy interventions.

To investigate the role of behavioural interventions in animal disease management, we develop an innovative methodological approach, using a scenario-based cattle purchasing game to understand what drives farmers' cattle purchasing decisions, and the effects of behavioural interventions upon simulated cattle purchases in different contexts. The paper begins by outlining the challenges biosecurity policy makers face in seeking to change farmers' behaviour, and how measures of good farming could affect farmers' biosecurity behaviour. Secondly, the paper describes the methodology used to explore the relevance of these behavioural interventions within cattle purchasing policies. Thirdly, we present the results of 76 simulated purchasing events, describing the relationship between purchase choices, behavioural interventions, and farmers' strategic approach to cattle purchasing. In conclusion, the paper considers the wider role of behavioural interventions for biosecurity policy.

2. Behavioural interventions and good farming

In seeking regulation without legislation, 'behavioural insights' have become the leitmotif of neoliberal governments. Taking inspiration from Thaler and Sunstein (2008), the significance of 'choice architecture', defaults and nudging have seeped into all policy areas, providing the hope that 'soft-paternalism' can reach parts of the population other approaches cannot (Jones et al., 2010, 2011). Spawning its own governmental infrastructure and behavioural insights units, mnemonic acronyms such as 'Mindspace' (Cabinet Office and the Institute for Government, 2010) and 'EAST' (Behavioural Insights, 2014), these forms of 'neuroliberal' psychological governance (Whitehead et al., 2018) have exhorted policy makers to create behavioural cues that are easy to follow, draw on social norms and positively reinforce good behaviour. Reworked physical infrastructure, financial incentives, and a proliferation of signs and letters emphasising social and geographical norms, have been the result.

Whilst agricultural policy has been no stranger to attempts to coerce farmers into adopting new practices and behaviours, biosecurity policies have been late to the behavioural party. In part this reflects how many biosecurity policies are written into statute, tied to international agreements and trade regulations. Financial compensation is written into these regulations as a means of incentivizing compliance with disease eradication programs (Olmstead and Rhode, 2015). Yet, research has suggested that farmers' knowledge of financial compensation is limited such that for some diseases, compensation plays little role in their decision making (Hamilton-Webb et al., 2016). Other research suggests that compensation creates a 'moral hazard': farmers take more risks or fail to reduce biosecurity risks because of the financial insurance provided by compensation regimes (Bicknell et al., 1999; Gramig et al., 2009; Hennessy and Wolf, 2018; Kuchler and Hamm, 2000). Moral hazard may be dealt with through variable compensation (Fraser, 2016) or, as Barnes et al. (2015) suggest, encourage more innovative use of non-fiscal behavioural interventions.

Indeed, a much broader behavioural awakening of biosecurity policy has been triggered by governments recognising the rising costs of statutory animal disease control and seeking cost-sharing partnership governance (Enticott et al., 2011). Attempts to develop cultural 'ownership' of disease amongst farmers by increasingly using non-regulatory behavioural interventions should therefore be understood in this light. In the United Kingdom, endemic diseases such as bTB have therefore attracted considerable attention with biosecurity policy makers seeking to redefine it as a 'sociological problem' as much as an epidemiological one (Little, 2019). Whilst scientific studies of bTB have highlighted the challenge of 'cultural ownership' (Independent Scientific Group (ISG). 2007), independent policy reviews have pointed towards farmer behaviour as a key barrier to effective disease control (Godfray et al., 2018). In response, governments have commissioned social research on biosecurity practices (Defra, 2020), whilst veterinary groups have argued that 'behavioural science should be central to the control, eradication and research of bTB' (British Veterinary Association (BVA). 2020).

Whilst these calls suggest the need to reorganise biosecurity research and policy through an integration of the social and natural sciences, Garza et al. (2020) provide a note of caution. Their study found a significant number (120) of behavioural biosecurity policies in seven European countries, many of which (91) appeared to match theoretical behavioural change frameworks. However, the most frequent strategies relied on the most basic interventions (such as providing information), and there was little evidence of the systematic use of methods from the behavioural sciences to develop these policies. If this suggests there remains some way to travel before the social sciences are integrated within biosecurity policy making, other research continues to highlight the potential value of these approaches. For example, research on the role of information cues reveals that biosecurity behaviours can be improved when messages are shown graphically, rather than linguistically or numerically (Merrill et al., 2019b). Drawing on Kahneman and Tversky's (1979) 'prospect theory' in which avoiding (financial) losses are preferable to accruing gains, Hansson and Lagerkvist (2014) show how farmers' disease management decisions reflect farmers individual assessments of risk. However, when farmers are faced with managing an ongoing disease outbreak, decisions reflect a preference of avoiding losses; gains are only preferred when they seek to prevent future disease outbreaks. Other research has sought to examine how social information and the behaviour of other farmers can influence farmers' biosecurity decisions. Using an experimental simulation, Merrill et al. (2019a) for instance show that willingness to invest in biosecurity decreases when information on environmental disease prevalence is uncertain, reflecting an optimism bias that farmers' herds will not become infected. Alternatively, when more information is provided about biosecurity practices on neighbouring farms, biosecurity investment decreases.

This work is interesting in that it suggests that social norms of what constitutes 'biosecurity citizenship' (Barker, 2010), appropriate conduct or what has been referred to as 'good farming' (Burton, 2004) may not be influential in biosecurity decision making. Burton (2004) suggests that 'good farming' refers not only to economic forms of capital, but symbolic cultural capital: the visible demonstration of practical knowledge such as good stockmanship, symbols of appropriate farm maintenance such as clean farmyards and tidy hedgerows, and attributes such as hard work. These symbols are encoded and disseminated within discursive scripts, reinforcing their cultural legitimacy (Vanclay and Enticott, 2011). In this way, good farming acts as a heuristic to provide a strategy to guide, interpret and make decisions in conditions of uncertainty. Other strategies of decision-making are available to farmers, however, and the selection of good farming to guide decisions represents what Sunstein and Ullmann-Margalit (1999) refer to as a second-order decision.

For Burton and Paragahawewa (2011), the value of the good farmer approach lies in recognising and utilising cultural capital to create more culturally salient agricultural policy. Rather than simply rely on financial payments, they instead recommend the development and incorporation of measures of cultural capital into agricultural policy, and/or restructuring agricultural policy to directly encourage the generation of cultural capital. This may include directly measuring farmers' 'skills' in order to allow them to publicly demonstrate what is valued by the farming community. Whilst Burton and Paragahawewa (2011) note that some cultural values might be hard to measure (such as 'tidy fields'), objectifying cattle purchasing skills may provide a relatively easy way of incorporating the cultural capital of good farming into animal disease management policy. For example, recent research has established a link between farmers' understandings of good farming and biosecurity practices (Naylor et al., 2018; Shortall and Brown, 2020; Shortall et al., 2018). In particular, cattle purchasing is likely to be connected to and reflect good farming in a number of ways. Firstly, purchasing cattle risks

the introduction and transmission of new diseases to animals within the herd and, for some diseases that can be subsequently transmitted within the local environment, to animals on neighbouring farms. For those farms that need to replace stock, however, different forms of institutional capital – such as certification and ranking schemes – can help provide assurance to the purchaser that they are buying from a good farmer and are running the risk of being labelled a bad farmer by introducing disease into their herd or area. For example, Enticott et al. (2021) describe how the number of years a farm has been free from disease effectively establishes a good farming rating that may incentivise improved biosecurity when it is required to be displayed at the point of sale. The extent to which these forms of information are a reliable guide to whether the farmer is a 'good farmer' may, however, be compromised by farmers' own spatial understanding of disease transmission and by blaming disease outbreaks on perceived government failings, rather than 'bad farming' (Enticott, 2008, 2016).

Secondly, the avoidance of disease through careful cattle purchasing should allow farmers to display other forms of symbolic cultural capital. An outbreak of bTB, for instance, would lead to a farm's business being subject to a range of trading restrictions, denying the opportunity to farm with autonomy, which is highly valued by farmers in the farming script of 'being my own boss' (Vanclay and Enticott, 2011) which symbolises farmers' success at running their own farm well rather than being told how to farm by government. Indeed, an outbreak of bTB would mean that many farming decisions would be subject to bureaucratic procedures and determined by government officials: farmers would be unable to attend market to sell their cattle. As a result, farms may become over-stocked, and cattle suffer poor welfare. Failing to avoid disease through responsible cattle purchasing therefore compromises farmers' abilities to display the embodied and practical skills of the good farmer symbolised by good-looking cattle either on show at markets or at pasture. Similarly, participation at livestock markets reflects the significance of the autonomous farmer consistent with good farming. Providing measures of good farming in relation to animal disease may therefore help cattle purchasers identify good farmers, and help them avoid becoming a bad farmer as a consequence of poor cattle purchases. The extent to which such measures can successfully symbolise the good farmer and influence cattle purchasing is explored in the remainder of this paper.

3. Interventions to influence cattle purchasing and animal disease

Studies of behavioural influences in disease management reveal two distinct methodological approaches. On the one hand, agricultural economists, drawing on methodologies from behavioural psychology, have conducted experiments to simulate the effects of information provision and financial incentives upon biosecurity behaviours. On the other hand, sociological research has sought to conceptualise and describe in-depth farmers' responses to disease events and policy interventions. Each has their problems. Despite the promise of the experimental approach, research participants are often students responding to hypothetical situations wholly divorced from the practical skills and situational awareness that farmers use to respond to real-life context-dependent situations (Merrill et al., 2019a, 2019b). By contrast, qualitative analyses of good farming and biosecurity, whilst focused on real-world policies and disease incursions, are retrospective and subject to recall and social desirability biases. Rather than adopting one or the other, we seek to develop an innovative mixed-methods approach that allows us to quantitatively and qualitatively assess the value of symbolising good farming to influence farmers' cattle purchasing decisions to prevent bTB. The following sections firstly provide information on the importance of bTB and the relevance of cattle purchasing before providing a detailed account of our methodological approach.

3.1. Bovine tuberculosis and cattle purchasing

In the United Kingdom, bTB is the UK's most challenging endemic disease, resulting in the premature death of approximately 35,000 cattle and costing the taxpayer in excess of £100 m every year (Defra, 2020). Managed by the government, the disease has a complex epidemiology involving transmission by legally protected wildlife, the culling of which for disease control purposes has raised political, social and economic challenges (Grant, 2009; Independent Scientific Group (ISG). 2007). Cattle movements have become recognised as an important part of the epidemiology of bTB. Studies have shown how the movement of cattle is one of the most important risk factors in infected herds, whilst movements also translocate disease from areas of high to low prevalence (Gilbert et al., 2005; Green et al., 2008; Johnston et al., 2005a, 2005b, 2011). Whilst infected farms are restricted by law from buying or moving cattle on or off farms, all other farms are free to act as they please. Nevertheless, the limitations of diagnostic tests and their frequency mean that these movements still pose a risk to other farmers. Indeed, other countries with successful bTB eradication schemes, have governed the movement of all cattle between areas of different epidemiological risk using statutory and/or voluntary policies of 'risk based trading' (Livingstone et al., 2015; More et al., 2015) and in doing so identify and provide cultural capital to good farmers. Whilst no such scheme currently exists in the UK for bTB, policy makers view cattle purchasing as an important practice on which to apply the behavioural sciences in order to govern cattle movements through behavioural nudges rather than regulation.

3.2. Methodological tools to understand good farming and cattle purchasing

To understand the impact of different ways of objectifying good farming, we devised a novel mixed-methods approach. Avoiding experimental approaches involving non-farmers, our approach involved simulating cattle purchasing with farmers who buy and sell cattle. Many studies within the behavioural sciences involve randomised controlled trials, but this approach was not available and not suitable: we were not able to alter the information provided at the point of sale (such as at cattle markets). The diversity of cattle, buyers and sellers also makes controlling for the effect of a single intervention a significant methodological challenge. Instead, our approach sought to simulate cattle purchasing, whilst also allowing farmers to reflectively deliberate on the reasons for their purchases and the value of different behavioural insights. To do this, we developed cattle purchasing game ("Game of Farming Life") in Mural – a web-based interactive whiteboard (www.mural.com) – in which participants moved around a Monopoly-style board (see Fig. 1). Players progressed around the board by rolling one die. All games were played online via Zoom due to Covid 19 lockdown restrictions.

Game play was organised using a "branch and bottleneck" structure. Branches reflect different contextual influences that participants land on at random throughout the game. This allowed us to introduce an element of competitiveness between players: points were awarded for landing on squares that reflected 'positive' contexts. No points were awarded for landing on negative blue squares. Red squares were a bTB test: if players landed on these, they were required to roll an even number to pass the bTB test, otherwise they would miss a go. Bottlenecks were cattle purchasing events that all players had to complete at the same time and were located in each corner square of the game board. Once one player reached a corner square, all other players also moved there. Players were then read a cattle purchasing scenario and asked to make a choice between four adverts. Scenarios are widely used in research to simulate decision-making environments. They provide opportunities to elicit attitudes and beliefs about complex and potentially sensitive situations (Hulme and Dessai, 2008; Quine et al., 2011; Soleri and Cleveland, 2005) and to examine how people may respond to future

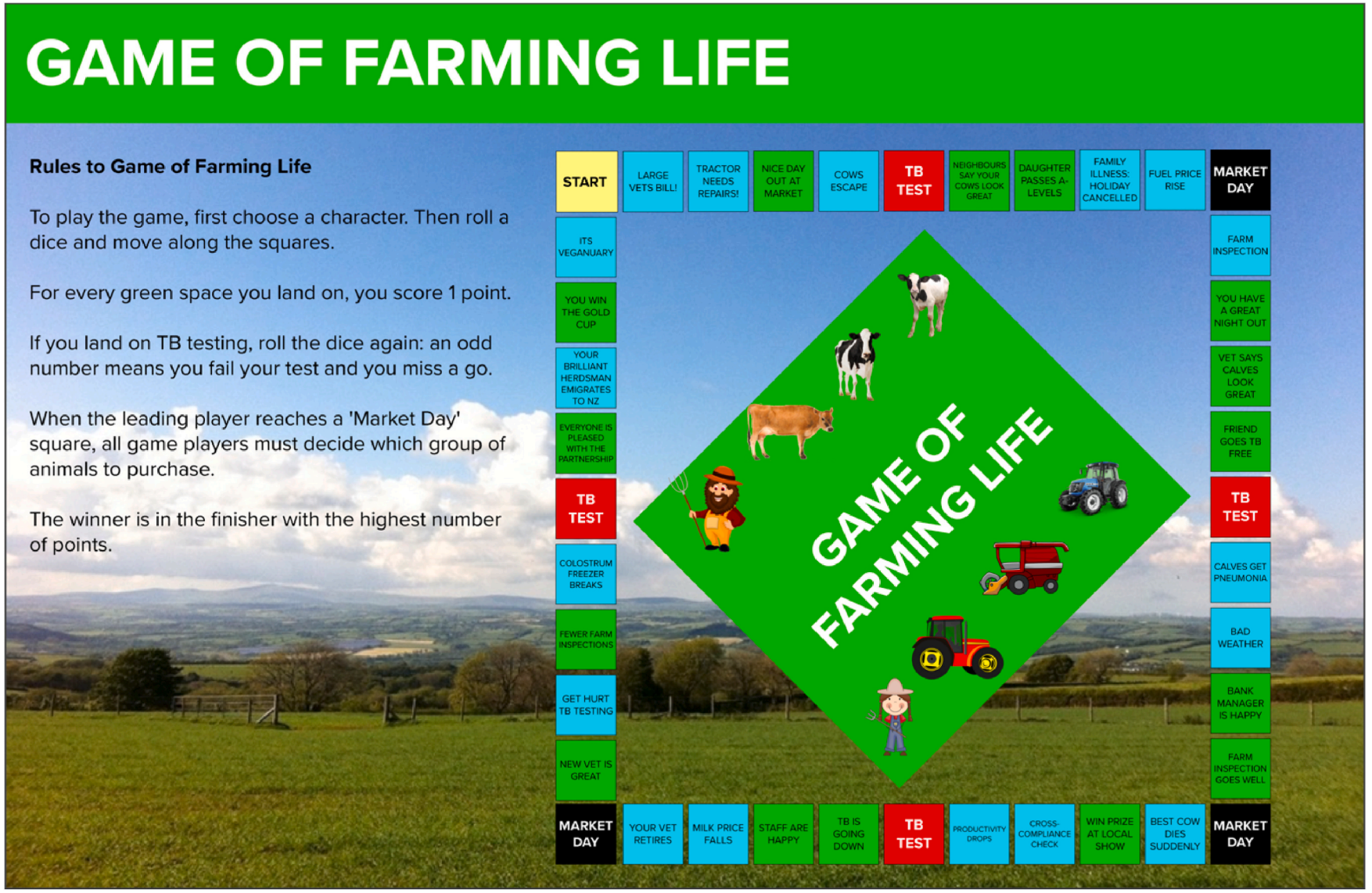

Fig. 1. The game board used to simulate cattle purchasing.

events (van der Heijden, 1996). Scenarios work best when they are based on plausible and familiar situations (Quine et al., 2011). Scenarios were therefore developed based on a prior research project on cattle purchasing involving farmers and vets. To ensure the scenarios reflected real-world cattle purchasing opportunities, specific versions were developed for three sectors: dairy, store cattle, and calf-rearing. An example of a scenario for dairy farmers is shown below:

> "You are looking to buy some replacement cows to replace some cull cows. You don't have much time and have seen that there are four dispersal sales coming up over the next couple of days. The Agents have sent you the programme with various details and she thinks that you'll definitely find what you are looking for in one of the herds. The Agent's auctioneer tells you that she doesn't think there'll be much variation in price, the question is which one are you most keen on?" (Dairy, Scenario 1)

For each scenario and livestock sector, four cattle adverts were developed, reflecting different ways of purchasing: at market, private sale, and mediated sale (via an Agent). At purchasing decision points participants were required to select one of the four lots to buy. To ensure realism, the adverts were based on publicly available sales catalogues collected from livestock markets, private sales and websites. Adverts therefore contained information on the animals for sale, their source, and a picture: adverts were therefore heterogeneous to reflect real-world purchasing. Adverts were created in PowerPoint (see Fig. 2) and shown to participants by screen-sharing. Depending on participants' screen size, adverts were either shown individually, or all together. Following the purchasing exercise, the game recommenced from the corner square.

3.2.1. Good farming information

For each scenario, adverts contained information to symbolise good farming in order to influence purchase choices. Firstly, farmers could use pictures of the animals to derive good farming information. For scenarios 1 and 2, pictures were of cattle in a livestock market, but for scenarios 3 and 4 animals were pictured on farm. Secondly, adverts featured two different conceptual measures of good farming. All adverts contained a logo stating how many years free the herd had been from bTB and the geographical average years free for the area in which the farm was located. Values were set randomly. In this method, good farming is symbolised by longer periods of disease freedom; 'bad farmers' would avoid purchasing from farms who had recently had an outbreak for fear of introducing disease. Scenarios 2 and 4 also contained a 'Good Farmer Rating' to graphically indicate the percentage of satisfied previous customers for each vendor. The aim of this logo was to convey levels of trust and reputation of the seller, which had seen to be important considerations when purchasing cattle from our previous research, and found in other research by Hidano et al. (2019). Presented as a star rating, the logo was similar to review ratings found on internet shopping sites. Two ratings were set at 95% and two at 70% satisfaction.

In addition to these measures of good farming, scenarios 1 and 3 explored the effect of different compensation regimes upon purchase decisions. Two different schemes were presented: two sales adverts stated that the purchaser would receive 50% compensation if the animal ever tested positive for bTB in future.[1] This allowed us to explore the relationship between the use of good-farming and other second-order decision making strategies when purchasing cattle, specifically whether a preference for avoiding financial losses was a significant factor in cattle purchasing. The remaining two adverts stated that 100% compensation would be given so long as the purchaser conducted a post-movement bTB test. A final scenario contained a mixture of all the information and logos shown in the previous three scenarios: some adverts contained the Good Farmer Rating, and others different compensation values. The purpose of this was to provide a complex information landscape from which to choose cattle to purchase.

3.3. Game participants

Participants were recruited from multiple sources. Firstly, we contacted farmers who had participated in prior cattle purchasing research and indicated willingness to participate in further research. Secondly, we used social media (Twitter and Facebook groups) to recruit participants. Thirdly, we used snowball sampling from early game participants and recommendations from vets. Participation was incentivized by a £25 gift voucher that was sent to all participants on completion of the game. The majority of game players were from dairy farms (see Table 1 for participant characteristics). In order to ensure that scenarios were relevant, participants were matched to scenarios that reflected their farming type. The game was piloted with 2 farmers, but no changes were made to the game and these farmers are included in the overall analysis.

Games were played during the evening and lunchtimes to fit around farmers' work commitments and on average lasted 1 h 18 min. In all purchasing scenarios, participants spent time considering and weighing up the information. Indeed, in three cases, a participant was unable to make a choice from any of the adverts. Comments by the participants during the game suggested that the scenarios were plausible and realistic. Online game play limited the use of other props that can be used in gaming methodologies (see for example: Tewdwr-Jones and Wilson, 2022). Moreover, exploration of the context squares used in the gameplay was limited due to time: future uses of the game could use these in more depth to develop context specific purchasing decisions. Nevertheless, whilst findings should be interpreted in the context of the game, the context squares played an important role in keeping the game situated within the challenge of bTB. Moreover, participants commented that they found the process enjoyable and a helpful way of talking about cattle purchasing, and it was notable that the game play prompted conversations about why a decision had been taken between participants.

3.4. Analysis

Each game was facilitated by two researchers. Farmers were encouraged to talk through their purchasing decisions as they made their choices and explain their reasons after each purchasing event. Farmers were asked about each of the behavioural interventions during and at the end of the game. These discussions were recorded within Zoom, transcribed and cross-checked with notes taken during the game. Analysis of in-game cattle purchases identified and recorded each factor mentioned by farmers in their explanation of their purchase choice. Similar factors were grouped together and organised into five main categories. Transcripts were analysed thematically within Nvivo to elicit the key similarities between participants in relation to their views of the information provided and the rationales for their purchasing.

4. Analysing the role of good farming in cattle purchasing decisions

Ten separate games were played involving 19 participants and a total of 76 different purchases. In the following section, we firstly describe the factors farmers cited when making their cattle purchases; secondly, we report on how the different behavioural interventions were represented within their purchase choices; and thirdly we draw on qualitative analysis to describe farmers' purchasing strategies and their implications for the salience of these behavioural interventions.

4.1. Quantitative description of in-game purchasing factors

Table 2 shows the total number of times different purchasing factors

[1] In England, farmers receive financial compensation for each animal slaughtered following a positive test for bTB. Standard valuations are set by the government varying according to age and type.

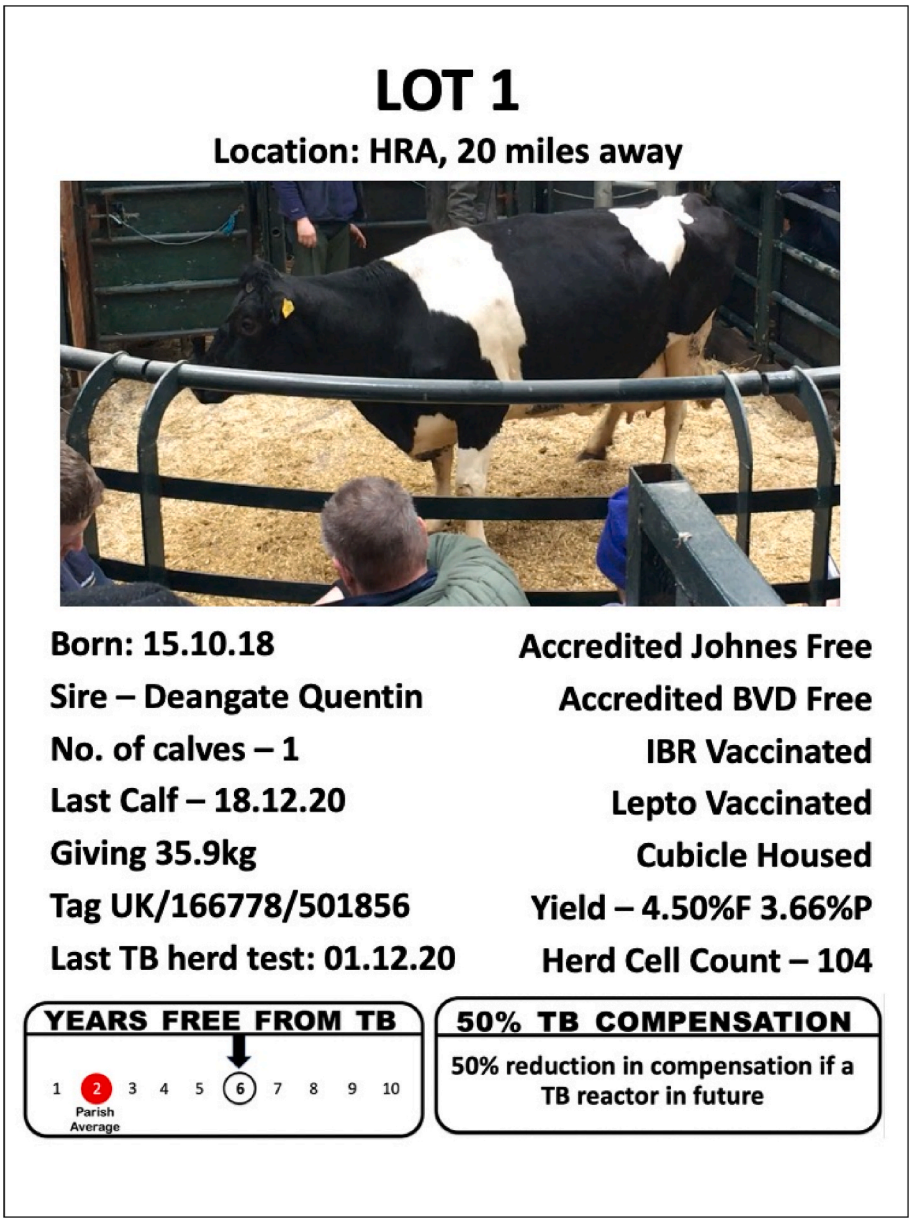

Fig. 2. Example of an advert used in the purchasing game.

were mentioned when participants made and justified their purchase choices. Overall, the most frequently mentioned factors were the vaccination status of the animal and its status in relation to production diseases other than bTB. When purchase factors are aggregated into categories, the most important factors were related to aspects of the animal on sale and production diseases, followed equally by bTB and management factors.

Farmers were particularly heavily swayed by the Johne's disease[2] status of each purchase choice, acting as an anchor or reference point for all other adverts. Around half of all disease factors were specifically about the vaccination status. This suggested that purchasing decisions were not multi-factorial but could be based on one criterion. As Player 3 commented for all his purchases, "Vaccination for major diseases, that's what I am really looking for".

Years free from bTB was the third most frequently mentioned factor. This is likely to reflect the fact that it featured in every sale advert and suggests that information on bTB at the point of sale may provide a limited cue to some purchasers. Similarly, bTB compensation was only ever discussed in relation to adverts where compensation was mentioned. Whilst the frequency of these factors is likely to be influenced by the information displayed in the adverts, results reflect previous research that has sought to identify the most influential factors in cattle purchasing (Defra, 2019; Little et al., 2017).

Table 3 shows how these factors vary between different purchase scenarios. For replacement dairy cows, production diseases were the most significant factor, followed by animal factors and then bTB. For purchases of calves, bTB was the least important factor, whilst management factors were the most important. For purchases of in-calf heifer calves the most popular factors were related to the animal, whilst bTB related factors were third.

[2] Johnes disease is a chronic wasting disease in ruminants. Unlike bTB, it is not subject to statutory controls or surveillance, and is managed instead by the agricultural and food industry.

Table 1
Farm Characteristics of game participants.

Player ID	Game no.	Participant Gender	Herd Type	Herd Size: Dairy	Herd Size: Beef	bTB Risk Area	Current bTB Status	In a Badger cull zone
Player P1	0 (Pilot)	Male	Dairy	475	0	LRA	bTB Free	No
Player P2	0 (Pilot)	Female	Dairy	475	0	LRA	bTB Free	No
Player 1	1	Male	Dairy	220		HRA	bTB Free	Yes
Player 2	1	Male	Calf Rearer	45		HRA	bTB Free	Yes
Player 3	2	Male	Dairy	140	0	Edge	bTB Free	Yes
Player 4	2	Male	Dairy	90	0	Edge	bTB Free	Yes
Player 5	3	Female	Dairy	120	0	HRA	bTB Free	Yes
Player 6	3	Female	Dairy	270	200	Edge	bTB Restricted	Yes
Player 7	4	Male	Beef Suckler	0	10	HRA	bTB Free	Yes
Player 8	4	Male	Beef Suckler	0	120	HRA	bTB Free	Yes
Player 9	5	Male	Dairy	450	0	Edge	bTB Restricted	No
Player 10	6	Male	Dairy	900	800	HRA	bTB Restricted	Yes
Player 11	6	Male	Dairy	900	800	HRA	bTB Restricted	Yes
Player 12	7	Female	Dairy	160		HRA	bTB Free	Yes
Player 13	8	Male	Dairy	290	40	HRA	bTB Free	Yes
Player 14	8	Female	Dairy	200	0	Intermediate (Wales)	bTB Restricted	No
Player 15	8	Female	Beef/Calf Rearer		15	Edge	bTB Free	No
Player 16	9	Female	Calf Rearer		240	HRA	bTB Free	No
Player 17	9	Male	Calf Rearer		240	HRA	bTB Free	No

Table 2
Factors mentioned when justifying in-game purchases.

ANIMAL	Sector			
	BEEF	CALF	DAIRY	ALL
	13	**8**	**59**	**80**
AGE		1	13	14
APPEARANCE - ANIMAL	2	2	11	15
BOUGHT IN AT CALF			1	1
BREED	4	1	8	13
CALVING			2	2
GENETICS	1	3	1	5
HOMEBRED	3	1	9	13
PRODUCTION - MILK			14	14
TEMPERAMENT	3			3
bTB	**18**	**1**	**41**	**61**
COMPENSATION - 100%	6	1	12	19
TB PARISH RATING	1			1
TB TEST DATE	2		7	9
TB TEST FREQUENCY	4		2	6
TB YEARS FREE	5		20	26
PRODUCTION DISEASE	**3**	**9**	**68**	**80**
PRODUCTION - DISEASES	3	3	31	37
VACCINATIONS		6	37	43
LOCATION	**2**			**2**
LOCATION - LOCAL	2			2
MANAGEMENT	**2**	**25**	**33**	**60**
APPEARANCE - FARM		6	3	9
GOOD FARMER RATING	1	2	6	9
MANAGEMENT - CALF REARER		2	6	8
MANAGEMENT - CLOSED HERD		1	1	2
MANAGEMENT - COLOSTRUM		4	2	6
MANAGEMENT - CUBICLE TRAINED			6	6
MANAGEMENT - GENERAL	1		2	3
MANAGEMENT - HEALTH		2	4	6
MANAGEMENT - HOUSING		6	2	8
MANAGEMENT - REARING			1	1
MANAGEMENT - SIMILARITY		2		2
Grand Total	**38**	**43**	**201**	**283**

4.2. Assessment of behavioural interventions

In contrast to the purchasing factors, adverts with high bTB ratings were chosen more frequently. In total, 39 in-game purchase choices were made which involved considering adverts with different bTB statuses. Over half (25) of these in-game choices were of cattle with a high bTB rating (i.e. 7-9 years bTB Free). Fourteen in-game purchases were of cattle with the lowest bTB status (2–4 years bTB free). One further choice was of cattle whose status was on the midpoint (5 years bTB free) and between the lowest and highest options. For all game players, ten consistently chose purchase options with the highest bTB rating, five the lowest, and three chose a range of options.

Farmers did not appear to pay much attention to the geographical average of bTB to guide their purchase. Farmers suggested that the comparison needed more context to be valid: parishes could vary in size and by number of farms. A more reliable and standardised denominator (such as the ten closest farms) may have more salience. However, discrepancies between parish and herd bTB ratings prompted some farmers to indicate that this was something that they would follow-up with the vendor to get an explanation.

20 of the 37 in-game cattle purchases involved cattle that would receive 100% of statutory compensation (if it subsequently became a bTB reactor during its life) if the purchase was subject to a post-movement test. Comparing choices made in each scenario reveals that most (10) farmers did not have a preference for higher or lower compensation, five always chose options with higher compensation, and 3 chose options with lower compensation.

Of the 18 in-game purchases, only four were of purchase options that had the highest rating or 95% satisfaction. The remainder (14) were purchases of cattle with lower (70%) purchaser satisfaction. In scenario 4, the good farmer information featured on half (2) of the purchase choices. Participants chose an advert featuring a good farmer logo in 14 out of 18 purchase choices. Choices were distributed equally between the highest and lowest good farmer ratings (7 in-game purchases for each).

4.3. Qualitative explanation of cattle purchasing strategies

The apparent differences between the stated purchasing factors and the relevance of the different behavioural influences were explained through participants' purchasing rationales and deliberations on the information provided. Preferences towards less risky cattle, we argue, was not a consequence of the information provided, but coincidental to a common cattle purchasing strategy that we call 'fitting the system'.

4.3.1. Fitting the system

In reflecting on their purchasing choices and the information that was most salient to them, farmers articulated a purchasing strategy best described as 'fitting the system'. This strategy aims to fit or match new cattle purchases to the farm system to ensure its continuity. When faced with a range of purchasing options, 'fitting the system' therefore acts as a kind of 'radar', honing on those factors that are most pertinent to the system. In-game purchases reflected the need to match systems in a number of ways. For dairy cows, players commented that cows that were

Table 3
Factors mentioned when justifying in-game purchases by purchase scenario.

Row Labels	Purchase Scenario CALVES	COWS	IN-CALF HEIFERS	STORE CATTLE	ALL
ANIMAL	**23**	**28**	**16**	**13**	**80**
AGE	3	10	1		14
APPEARANCE - ANIMAL	7	2	4	2	15
BOUGHT IN AT CALF			1		1
BREED	1	1	7	4	13
CALVING		1	1		2
GENETICS	3		1	1	5
HOMEBRED	9	1		3	13
PRODUCTION - MILK		13	1		14
TEMPERAMENT				3	3
bTB	**10**	**24**	**8**	**18**	**61**
COMPENSATION - 100%	3	4	6	6	19
TB PARISH RATING				1	1
TB TEST DATE		7		2	9
TB TEST FREQUENCY		1	1	4	6
TB YEARS FREE	7	12	1	5	26
DISEASE	**21**	**44**	**12**	**3**	**80**
PRODUCTION - DISEASES	8	24	2	3	37
VACCINATIONS	13	20	10		43
LOCATION				**2**	**2**
LOCATION - LOCAL				2	2
MANAGEMENT	**40**	**11**	**7**	**2**	**60**
APPEARANCE - FARM	8		1		9
GOOD FARMER RATING	3	5		1	9
MANAGEMENT - CALF REARER	8				8
MANAGEMENT - CLOSED HERD	1	1			2
MANAGEMENT - COLOSTRUM	6				6
MANAGEMENT - CUBICLE TRAINED		4	2		6
MANAGEMENT - GENERAL	1	1		1	3
MANAGEMENT - HEALTH	3		3		6
MANAGEMENT - HOUSING	8				8
MANAGEMENT - REARING			1		1
MANAGEMENT - SIMILARITY	2				2
Grand Total	**94**	**107**	**43**	**38**	**283**

cubicle trained were preferred. Information on what cows were being fed was not contained in any adverts, but players suggested that they would want to know that information to ensure a match to their own systems when possible. For calves, Player 16 chose advert 2, justifying the purchase because from the advert, it appeared that the 'set up was very similar to what we've got in terms of the conditions, the vaccinations and the colostrum management'. The importance of a similar set-up was to minimise the stress placed upon animals when they are moved and for them to have similar levels of immunity, so that they are not susceptible to illness. Thus, rather than factors relating to bTB, it was the importance of matching these systems that was vital for this purchase:

> "the TB didn't come into it, [I was] interested more in calf management … Compensation isn't the biggest issues and is not the reason why you would buy them … TB isn't the biggest [issue], we know there's a risk … [but] its really important they have had colostrum" (Player 16)

In a perfect environment, fitting the system is a straightforward task. However, the farming environment is uncertain and dynamic both in terms of the availability of and demand for cattle meaning that purchasing is challenging:

> "It is so, so difficult. You know, the perfect animal barely exists. It's difficult enough to find a substantial sale where you can get a good selection of what you hope you're going to want to buy and, yeah, you can go shopping overseas instead but that is not without risk. There's equal amount of risk doing that" (Player 9)

The lack of a perfect fit meant that purchases would usually be the result of compromising on an animal's range of qualities. Even where farmers had sought to secure good and reliable supply chains, compromise could still be built into these relationships. For example, Player 17 recounted how establishing good supplier relationships meant 'taking the rough with the smooth' such that a batch of calves would always include some good and some less good calves. Cherry picking the best animals to leave the supplier with the worst ones they could not sell was not seen as the best way to maintain a relationship with the supplier. Farmers argued that this purchasing relationship was more productive for both sides and could lead to better animals overall in the long-term by allowing the purchaser to have input into the breeding and care of the animals:

> "we sort of batch buy rather than cherry pick, because from a cherry-picking point of view, I try and make it work for … for everybody, for him and for us. Obviously … that's got to be reflected in the price, but sometimes we just agree on a set price, so you take the rough with the smooth. You know, you'll take a poor one and a good one. Sometimes you win and sometimes you lose … but for us, it's … the relationship and the calves he produces. Sometimes you might not be getting as good a batch, but it's just a case of taking the rough with the smooth, and not cherry picking, because you take all the good, and the dairy farmer is left then with all the bad stuff that he's got to try and sell' (Player 17)

4.3.2. Good farming and fitting the system

Whilst fitting the system provided an overall framework for cattle purchasing, dimensions of good farming were important in shaping how decisions were made. The challenges of fitting the system meant that trust and reliability in the seller became key factors in deciding what to buy. This was evident when farmers were asked to choose between an agent supplying cattle or buying from their neighbour. In this scenario, farmers highlighted the importance of local knowledge. For example, Player 3 commented that, "if it's the same cow then you go for the neighbour, you know more stuff from driving past". Similarly, Player 12 suggested that they "would walk away [from the dealer] and look at the neighbours' [cows] because we know their farming system and they are in tune with what we are doing". Other dimensions of local knowledge included the ability to draw on vets' knowledge and their connections with other vets. Player 9, for example, suggested that their vet could speak to the vendor's vet to "get into the nitty gritty and find out why the animals are on sale".

The effect of providing information on the good farming status of the vendor had a mixed effect. Firstly, purchase choices with high good farmer scores were not widely chosen, indicating that other systemic factors took priority. Nevertheless, farmers reacted positively to this rating, comparing it to 'Amazon-style' ratings and demonstrating the face-validity of this good farming metric. However, whilst farmers thought the principle of articulating vendors' qualities in this way was good, it prompted further questions about what precisely the rating would mean, who would organise it, and how reliable it could be. Satisfaction of previous sales was generally seen as appropriate, but there were concerns about how easily this could be manipulated by 'fake' or misleading reviews arising from a genuine mistake by the vendor or purchaser. Similarly, farmers were concerned about the ability to compare between vendors if one had fewer sales than the other.

The apparent low salience of the good farmer rating may also be explained by the need to see in person the animals for sale, the farm and the farmer. During the game, farmers intently studied the pictures of the animals for sale, picking up on signs of conformation, temperament and condition such as the shine on their coat, and used them assess how the animals had been treated. For example, farmers commented that when buying calves, it was important to see how they reacted to other people and the vendor: if they were inquisitive and came over to see new people that was a good sign. If they ran away at the first sight of the vendor, that would indicate the animals had been poorly managed. Some adverts were rejected based on the physical appearance of the animals or the quality of the housing:

> "That Belgian Blue looks a bit wild" (Player 7, scenario 3)

> "You can see a calf that is behind based off its looks" (Player 5 scenario 4)

> "They look a bit hunched … I wouldn't want them..I don't like way it stands in the ring, it doesn't appeal, could be the cheapest option" (Player 3, scenario 3)

> "Lot 3 & 4 – I'd get rid of them straight away because [of the] scour on the wall" (Player 12 scenario 3)

However, it was not always easy to elicit from the pictures the quality of the animal, farmer or farm, prompting players to comment that they would prefer to be able to visit the farm. This offered farmers to gauge the trustworthiness and reputation of the vendor by being able to ask additional questions and determine from their answers whether they were 'good farmers' or not. This could include, for example, vendors' knowledge of the animal's history, and the records they keep. In this sense, purchases would partly be based on the farmer and the farm. Farmers commented that they would like to see that the farm was clean and tidy, the housing was of good quality and that the vendor had the 'right' attitude.

Secondly, the challenges of 'fitting the system' also impacted upon the relevance of bTB information and its ability to reflect good farming. Whilst farmers generally preferred high status bTB cattle, their choices reflected their attempts to match cattle to their own circumstances based from other information available. In general, farmers valued purchases with a higher number of years bTB free. However, they also viewed the bTB test as an indication that an animal was 'saleable' and there was no real consensus on the threshold of what constituted a 'safe' herd. Five or more years was generally seen as good, although some farmers suggested lower. In each case, however, the scarcity of available cattle with high bTB status meant that a better guide was to buy no lower than their current status.

The significance of bTB varied between purchase types and each players' experience of bTB. Where farmers had experienced many outbreaks and farmed in expectation of an outbreak, information on bTB was less important. This reflects fatalistic attitudes towards bTB described in Enticott (2008). However, where players had experienced a recent bTB outbreak, which had caused significant farm management problems, information about bTB was more important. Information on bTB was more likely to be salient when it was timely: farmers who were restocking following a bTB incident particularly valued this information. However, it was not the only factor: Player 9, for example, suggested bTB accounted for 50% of the purchase decision, and other factors could over-ride its significance.

In this sense, fitting the system could reflect the wider epidemiological picture surrounding the farm. For example, Player 9 commented that "the closer geographically you are then closer to the same TB situation, [its best to] stick with the problems you know". However, for some animals, such as calves, some farmers suggested these dimensions of local fit were not important. Player 2, for example, suggested that "young calves spend so little time in the environment to pick up the disease". Nevertheless, this farmer was happy to buy calves from the high-risk area so long as the farm's biosecurity was good:

> "one of the guys I buy calves off, he's right in the middle of the high risk area I'm not even allowed in the building, I have to dip my boots and they bring the calves out to me … [But] even if all his neighbours were shut down, I'd still carry on buying calves from him, because they're just so hot on their health and security. And it shows in the calves. You know, I hardly ever have to do anything with any of their calves. They just come in, and just roar away" (Player 2)

In general, information on bTB appeared to play an 'arbitrating role' helping to differentiate between two equally 'good' animals for sale. This seemed to be most relevant for compensation incentives. Where adverts appeared to be of similar quality, the potential for additional compensation could sway the decision, all other things being equal (such as price). As full compensation was linked to the completion of post-movement testing, the attractiveness of this incentive also depended on the relative ease of completing this test. Where farmers were already frequently testing, the requirement to post-movement test was not considered onerous, meaning animals with full compensation were more attractive. Equally, the extent to which information could arbitrate between two adverts depended on the value of compensation itself. Player 3, for example, argued that the value of additional production would outweigh the value of compensation:

> "Lot 1 is going to give more milk, and the difference in TB risk and the compensation between Lot 1 and Lot 2 isn't worth it".

Compensation incentives therefore seem unlikely to drive sales, and in some cases depending on its perceived value, may not arbitrate between choices either.

5. Discussion

This paper has investigated the salience of different behavioural interventions to influence farmers' cattle purchasing decisions. In this section, we consider the wider implications of our research.

Firstly, the development and use of a scenario-based game has much to offer studies of biosecurity and other land-use policy issues. Participants enjoyed playing the game and reported that it helped them to think and talk about their cattle purchasing decisions. Following Quine et al. (2011), our purchasing scenarios were realistic, prompting some participants to reflect on times when the scenarios had played out in real life. Importantly, the use of the game also highlights the need for methodological triangulation when considering the impact of behavioural interventions within farming. Results from the game varied according to methodological and analytical techniques. Based on the analysis of purchasing rationales, results suggested that purchasing was primarily related to production factors. Analysis of the in-game purchases suggested that farmers preferred cattle from farms at a low-risk from bTB. Meanwhile, qualitative analysis of farmers revealed that farmers strategic approach to cattle purchasing of fitting the system meant that behavioural interventions were of limited consequence: the fact that they chose cattle with low bTB risks was coincidental. It is possible that our results reflect the way our participants were drawn primarily from the dairy sector rather than beef or calf-rearing sectors. Framing cattle purchasing in terms of short-term needs rather than establishing longer-term supply chains may also have elicited less frequent mentions of trust, reciprocity and 'good farming'. These alternative scenario framings may have enhanced the significance of our 'good farming rating' but was nonetheless revealed in our qualitative analysis of our general discussions with farmers during the game.

Our methodological approach therefore raises questions for how other research on behavioural insights within agricultural policy might be tested. In fact, a recent review of the agricultural behaviour change literature (AHDB, 2018) found relatively few studies of behavioural interventions, most of which relied on education rather than behavioural insights. Moreover, whilst some innovative methodologies were

found (Reed and Claunch, 2017), others relied on experimental methods that provide little insight into the differences between control and intervention groups (Donham et al., 2013; Jansen et al., 2010; Leach et al., 2013). Alternatively, multiple interventions are applied to multiple contexts making delineating their effects methodologically challenging (Lam et al., 2017). Whilst calls have been made for greater methodological quality of behavioural intervention studies in agriculture (AHDB, 2018), there is a risk that reliance on experimental methods overlooks the many and varied contexts of agricultural activities such as cattle purchasing. A key contribution of our research is therefore to respond to these concerns and provide complimentary methods to address these challenges.

Secondly, whilst 'good farming' has been explored conceptually in relation to biosecurity, this study responds to Burton and Paragahawewa's (2011) challenge of developing good farming measures for a specific biosecurity practice. Although such measures are not without their problems, in relation to cattle purchasing we have shown that good farming measures can play a role in shaping farmers' cattle purchasing decisions, forming an important part of farmers' purchasing 'radar' used to match cattle to their system. The process of matching purchases to farming systems observed in our study reflects what Burton et al. (2012) describe as an attempt to build a 'cowshed culture' – a 'self-reinforcing culture in which animals, humans and the physical structure all contribute to the development of farm specific ways of doing and being'. Designing and reinforcing a system that promotes 'positive interactions' between the human and non-human constitutive elements is central to a farm's success. The purchasing strategy of 'fitting the system' therefore reflects an attempt to maintain such positive interactions. Indeed, as Hidano et al. (2019) suggest, 'livestock purchasing practices seem to be shaped in the process of establishing cowshed culture, rather than farmers choosing "best" cows for their farms after considering a whole range of animal characteristics'.

In describing how farmers seek to 'fit the system' through their cattle purchases, we have also highlighted the trade-offs that farmers must make. The absence of the perfect animal means that fitting the system requires 'skilled craftwork' to identify the best animals to fit the system whilst also recognising the limits to this work (Higgins et al., 2018). These skills are reflective of the kinds of judgments made about stock when purchasing them such as their likely productivity based on their conformation, appearance and behaviour. However, estimations of good farming are also relevant here. On the one hand, good farming metrics may play a role in helping farmers to decide which stock to buy by providing reassurance that the vendor is not 'dodgy' but an 'honest dealer' (Hidano et al., 2019). On the other hand, whilst farmers reacted positively and more enthusiastically to our good farmer rating than traditional metrics of disease control, it was also simplistic and unable to capture all the dimensions of good farming. This may explain why personal contacts and reliance on long-standing trusted trading relationships are preferred by many farmers. Nevertheless, further development and testing of other ways of expressing good farming for biosecurity should take place. For example, a pictorial farm portrait may help convey good farming status better than a simple metric. Such an approach, whilst ostensibly less objective, may allow farmers to build their own assessments and be comfortable with their limitations because they reflect their own cultural values. Indeed, as recent biosecurity research has suggested, recognising and living with the limits to biosecurity boundaries is what makes them work (Enticott, 2012; Higgins et al., 2018; Hinchliffe et al., 2013).

Finally, In showing how this fitting process works for cattle purchasing, we have also demonstrated how farmers' decisions reflect a hierarchy of second-order strategies in which first-hand experience of the animals and vendor takes priority over representations of good farming in satisfaction ratings or disease information but which is more important than financial incentives and aversion to financial loss. However, it is also the case that these strategies and the relative importance of different information will vary between different segments of the farming population and according to different disease contexts. However, it may also be the case that the social context of disease management may also play an important role in determining the use of information available at the point of sale but which is not factored into narrowly defined approaches to behavioural 'nudging'. For Michie and West (2013), this suggests that a range of behavioural interventions that may include both regulatory and persuasive techniques is required in order to be developed addressing different behavioural mechanisms is required (see for example, Lam et al., 2017). For others, the main problem with attempts to alter behaviour through the provision of information is that they fail to secure 'norm internalisation' (Mols et al., 2015), providing only short-term solutions. This is particularly the case when they relate to collective action to manage risks that affect everyone such as disease control (Jetten et al., 2020). The answer to this problem may lie in moving away from 'neuroliberal' solutions that 'infantalise' people as unable to deal with complexity towards approaches that seek to engage them in co-producing their futures rather than by-passing their irrationality (Jones et al., 2010). As Drury et al. (2019) show, when people view an existential threat in terms of the way it affects a community, they mobilise and coordinate collective solutions and ensure the community as a whole benefit rather than just the most able. The implications of these critiques for cattle purchasing is that behavioural change interventions may be most effective when they are designed and produced by the communities affected by them (Reicher et al., 2004). Indeed, our research revealed that farmers' purchases were already oriented towards disease management priorities (such as Johne's disease) when they reflected the priorities within private forms of regulation that had been developed within and by the farming industry rather than priorities that had been imposed by external regulators. This suggests that rather than focus on changing individual behaviour, changes to the organisation of regulation in which the private sector creates its own systems of bTB control and incentivized through contractual agreements with farmers may prove a more effective strategy of managing the movement of cattle.

6. Conclusion

In seeking to reduce the spread of disease between farms through voluntary means, cattle purchasing appears to be the ideal practice for policy makers to apply insights from the behavioural sciences. This paper has set out to explore the potential for such behavioural interventions, considering how different measures of good farming and financial incentives may influence farmers' purchasing decisions. In developing a unique scenario-based cattle purchasing game, this research shows how good farming fits into a broad decision making framework, showing how symbols and measures of good farming can influence cattle purchasing decisions. Whilst further research is required to explore the contextual salience of different behavioural interventions, our research suggests that farmers' strategic aim of 'fitting the system' is likely to over-ride the significance of information about bTB, allowing farmers to exercise cultural forms of 'craftwork', that includes the recognition and appreciation of 'good farmers' and 'good farming'. Financial incentives and information will be useful for some farmers in some circumstances, but their potential to provide the kind of cultural change within farming imagined by policy makers may be more elusive. Our research therefore provides important contextual detail on why these interventions may or may not work as intended. Rather, if controlling the movement of cattle between farms can deliver significant reductions in biosecurity risks, policy makers may wish to look to other regulatory controls to provide a more compelling signal.

Credit statement

Gareth Enticott: Conceptualisation, Methodology, Investigation, Formal analysis, writing. **Ruth Little**: Conceptualisation, Methodology, Investigation, Formal analysis, writing

Ethics statement

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to and the appropriate ethical review committee approval has been received from the School of Geography and Planning's research ethics committee at Cardiff University.

Declaration of competing interest

The authors declare no conflicts of interest.

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References

AHDB, 2018. Understand How to Influence Farmers' Decision-Making Behaviour a Social Science Literature Review. AHDB, Stoneleigh.
Barker, K., 2010. Biosecure citizenship: politicising symbiotic associations and the construction of biological threat. Trans. Inst. Br. Geogr. 35, 350–363.
Barnes, A.P., Moxey, A.P., Vosough Ahmadi, B., Borthwick, F.A., 2015. The effect of animal health compensation on 'positive' behaviours towards exotic disease reporting and implementing biosecurity: a review, a synthesis and a research agenda. Prev. Vet. Med. 122, 42–52.
Behavioural Insights, 2014. EAST. Four Simple Ways to Apply Behavioural Insights. BIT, London.
Bicknell, K.B., Wilen, J.E., Howitt, R.E., 1999. Public policy and private incentives for livestock disease control. Aust. J. Agric. Resour. Econ. 43, 501–521.
British Veterinary Association (BVA), 2020. BVA Policy Position on the Control and Eradication of Bovine TB. BVA, London.
Burton, R.J.F., 2004. Seeing through the 'good farmer's' eyes: towards developing an understanding of the social symbolic value of 'productivist' behaviour. Sociol. Rural. 44, 195–215.
Burton, R.J.F., Kuczera, C., Schwarz, G., 2008. Exploring farmers' cultural resistance to voluntary agri-environmental schemes. Sociol. Rural. 48, 16–37.
Burton, R.J.F., Paragahawewa, U.H., 2011. Creating culturally sustainable agri-environmental schemes. J. Rural Stud. 27, 95–104.
Burton, R.J.F., Peoples, S., Cooper, M.H., 2012. Building 'cowshed cultures': a cultural perspective on the promotion of stockmanship and animal welfare on dairy farms. J. Rural Stud. 28, 174–187.
Cabinet Office and the Institute for Government, 2010. Mindspace. Influencing Behaviour through Public Policy. Cabinet Office, London.
Carrique-Mas, J.J., Medley, G.F., Green, L.E., 2008. Risks for bovine tuberculosis in British cattle farms restocked after the foot and mouth disease epidemic of 2001. Prev. Vet. Med. 84, 85–93.
Cusworth, G., 2020. Falling short of being the 'good farmer': losses of social and cultural capital incurred through environmental mismanagement, and the long-term impacts agri-environment scheme participation. J. Rural Stud. 75, 164–173.
Defra, 2019. Cattle Farm Practices Survey 2019. Defra, London.
Defra, 2020. Next Steps for the Strategy for Achieving Bovine Tuberculosis Free Status for England. The Government's Response to the Strategy Review, 2018. Defra, London.
Donham, K.J., Kline, A.K., Kelly, K.M., Lange, J.L., Rautiainen, R.H., 2013. Respirator and hearing protection use in the certified safe farm program. J. Agromed. 18, 18–26.
Drury, J., Carter, H., Cocking, C., Ntontis, E., Tekin Guven, S., Amlôt, R., 2019. Facilitating collective psychosocial resilience in the public in emergencies: twelve recommendations based on the social identity approach. Front. Public Health 7, 141.
Enticott, G., 2008. The ecological paradox: social and natural consequences of the geographies of animal health promotion. Trans. Inst. Br. Geogr. 33, 433–446.
Enticott, G., 2012. The local universality of veterinary expertise and the geography of animal disease. Trans. Inst. Br. Geogr. 37, 75–88.
Enticott, G., 2016. Market instruments, biosecurity and place-based understandings of animal disease. J. Rural Stud. 45, 312–319.
Enticott, G., Donaldson, A., Lowe, P., Power, M., Proctor, A., Wilkinson, K., 2011. The changing role of veterinary expertise in the food chain. Phil. Trans. Biol. Sci. 366, 1955–1965.
Enticott, G., Gates, M.C., Hidano, A., 2021. "It's just the luck of the draw": luck, good farming and the management of animal disease in Aotearoa New Zealand. Geoforum 119, 143–151.
Franklin, A., Udall, D., Schmutz, U., Rayns, F., 2021. 'Hell or high water': good farming and environmental care as contested practices in the implementation of nitrate vulnerable zones in Wales. J. Rural Stud. 83, 146–154.
Fraser, R., 2016. Compensation payments and animal disease: incentivising farmers both to undertake costly on-farm biosecurity and to comply with disease reporting requirements. Environ. Resour. Econ. 70, 617–629.
Garza, M., Ågren, E.C.C., Lindberg, A., 2020. Nudging in animal disease control and surveillance: a qualitative approach to identify strategies used to improve compliance with animal health policies. Front. Vet. Sci. 7, 383.
Gilbert, M., Mitchell, A., Bourn, D., Mawdsley, J., Clifton-Hadley, R., Wint, W., 2005. Cattle movements and bovine tuberculosis in Great Britain. Nature 435, 491–496.
Godfray, C., Donnelly, C.A., Hewinson, G., Winter, M., Wood, J.L.N., 2018. Bovine TB Strategy Review. Defra, London.
Gramig, B.M., Horan, R.D., Wolf, C.A., 2009. Livestock disease indemnity design when moral hazard is followed by adverse selection. Am. J. Agric. Econ. 91, 627–641.
Grant, W., 2009. Intractable policy failure: the case of bovine TB and badgers. Br. J. Polit. Int. Relat. 11, 557–573.
Green, D.M., Kiss, I.Z., Mitchell, A.P., Kao, R.R., 2008. Estimates for local and movement-based transmission of bovine tuberculosis in British cattle. Proc. Biol. Sci. 275, 1001–1005.
Hamilton-Webb, A., Naylor, R., Little, R., Maye, D., 2016. Compensation and exotic livestock disease management: the views of animal keepers and veterinarians in England. Vet. Rec. 179, 513.
Hansson, H., Lagerkvist, C.J., 2014. Decision making for animal health and welfare: integrating risk-benefit analysis with prospect theory. Risk Anal. 34, 1149–1159.
Hennessy, D.A., Wolf, C.A., 2018. Asymmetric information, externalities and incentives in animal disease prevention and control. J. Agric. Econ. 69, 226–242.
Hidano, A., Gates, M.C., Enticott, G., 2019. Farmers' decision making on livestock trading practices: cowshed culture and behavioral triggers amongst New Zealand dairy farmers. Front. Vet. Sci. 6, 320.
Higgins, V., Bryant, M., Hernández-Jover, M., Rast, L., McShane, C., 2018. Devolved responsibility and on-farm biosecurity: practices of biosecure farming care in livestock production. Sociol. Rural. 58, 20–39.
Hinchliffe, S., Allen, J., Lavau, S., Bingham, N., Carter, S., 2013. Biosecurity and the topologies of infected life: from borderlines to borderlands. Trans. Inst. Br. Geogr. 38, 531–543.
Hulme, M., Dessai, S., 2008. Negatiating future climates for public policy: a critical assessment of the development of climate scenarios for the UK. Environ. Sci. Pol. 11, 54–70.
Huttunen, S., Peltomaa, J., 2016. Agri-environmental policies and 'good farming' in cultivation practices at Finnish farms. J. Rural Stud. 44, 217–226.
Independent Scientific Group (ISG), 2007. Bovine Tuberculosis: the Scientific Evidence. Defra, London.
Jansen, J., Renes, R.J., Lam, T.J., 2010. Evaluation of two communication strategies to improve udder health management. J. Dairy Sci. 93, 604–612.
Jetten, J., Reicher, S., Haslam, S.A., Cruwys, T., 2020. Together Apart. The Psychology of Covid-19. Sage Publications, London.
Johnston, W.T., Gettinby, G., Cox, D.R., Donnelly, C.A., Bourne, J., Clifton-Hadley, R., Le Fevre, A.M., McInerney, J.P., Mitchell, A., Morrison, W.I., Woodroffe, R., 2005a. Herd-level risk factors associated with tuberculosis breakdowns among cattle herds in England before the 2001 foot-and-mouth disease epidemic. Biol. Lett. 1, 53–56.
Johnston, W.T., Gettinby, G., Cox, D.R., Donnelly, C.A., Bourne, J., Clifton-Hadley, R., Le Fevre, A.M., McInerney, J.P., Mitchell, A., Morrison, W.I., Woodroffe, R., 2005b. Herd-level risk factors associated with tuberculosis breakdowns among cattle herds in England before the 2001 foot-and-mouth disease epidemic. Biol. Lett. 1, 53–56.
Johnston, W.T., Vial, F., Gettinby, G., Bourne, F.J., Clifton-Hadley, R.S., Cox, D.R., Crea, P., Donnelly, C.A., McInerney, J.P., Mitchell, A.P., Morrison, W.I., Woodroffe, R., 2011. Herd-level risk factors of bovine tuberculosis in England and Wales after the 2001 foot-and-mouth disease epidemic. Int. J. Infect. Dis. 15, e833–e840.
Jones, R., Pykett, J., Whitehead, M., 2010. Governing temptation: changing behaviour in an age of libertarian paternalism. Prog. Hum. Geogr. 35, 483–501.
Jones, R., Pykett, J., Whitehead, M., 2011. The geographies of soft paternalism in the UK: the rise of the avuncular state and changing behaviour after neoliberalism. Geography Compass 5, 50–62.
Jones, R., Whitehead, M., 2018. 'Politics done like science': critical perspectives on psychological governance and the experimental state. Environ. Plann. D: Soc. Space 36 (2), 313–330.
Kahneman, D., Tversky, A., 1979. Prospect theory: an analysis of decision under risk. Econometrica 47, 263–291.
Kuchler, F., Hamm, S., 2000. Animal disease incidence and indemnity eradication programs. Agric. Econ. 22, 299–308.
Lam, T.J.G.M., Jansen, J., Wessels, R.J., 2017. The RESET Mindset Model applied on decreasing antibiotic usage in dairy cattle in The Netherlands. Ir. Vet. J. 70, 5.
Lastra-Bravo, X.B., Hubbard, C., Garrod, G., Tolón-Becerra, A., 2015. What drives farmers' participation in EU agri-environmental schemes?: results from a qualitative meta-analysis. Environ. Sci. Pol. 54, 1–9.
Leach, K.A., Paul, E.S., Whay, H.R., Barker, Z.E., Maggs, C.M., Sedgwick, A.K., Main, D. C., 2013. Reducing lameness in dairy herds–overcoming some barriers. Res. Vet. Sci. 94, 820–825.
Little, R., Wheeler, K., Edge, S., 2017. Developing a risk-based trading scheme for cattle in England: farmer perspectives on managing trading risk for bovine tuberculosis. Vet. Rec. 180, 148.
Little, R.A., 2019. Negotiated management strategies for bovine tuberculosis: enhancing risk mitigation in Michigan and the UK. Front. Vet. Sci. 6, 81.
Livingstone, P.G., Hancox, N., Nugent, G., Mackereth, G., Hutchings, S.A., 2015. Development of the New Zealand strategy for local eradication of tuberculosis from wildlife and livestock. N. Z. Vet. J. 63, 98–107.

Merrill, S.C., Koliba, C.J., Moegenburg, S.M., Zia, A., Parker, J., Sellnow, T., Wiltshire, S., Bucini, G., Danehy, C., Smith, J.M., 2019a. Decision-making in livestock biosecurity practices amidst environmental and social uncertainty: evidence from an experimental game. PLoS One 14, e0214500.
Merrill, S.C., Moegenburg, S., Koliba, C.J., Zia, A., Trinity, L., Clark, E., Bucini, G., Wiltshire, S., Sellnow, T., Sellnow, D., Smith, J.M., 2019b. Willingness to comply with biosecurity in livestock facilities: evidence from experimental simulations. Front. Vet. Sci. 6, 156-156.
Michie, S., West, R., 2013. Behaviour change theory and evidence: a presentation to Government. Health Psychol. Rev. 7, 1–22.
Mols, F., Haslam, S.A., Jetten, J., Steffens, N.K., 2015. Why a nudge is not enough: a social identity critique of governance by stealth. Eur. J. Polit. Res. 54, 81–98.
More, S.J., Radunz, B., Glanville, R.J., 2015. Lessons learned during the successful eradication of bovine tuberculosis from Australia. Vet. Rec. 177, 224–232.
Naylor, R., Hamilton-Webb, A., Little, R., Maye, D., 2018. The 'good farmer': farmer identities and the control of exotic livestock disease in England. Sociol. Rural. 58, 3–19.
Olmstead, A.L., Rhode, P.W., 2015. Arresting Contagion: Science, Policy, and Conflicts over Animal Disease Control. Harvard University Press, Cambridge, Mass.
Quine, C.P., Barnett, J., Dobson, A.D.M., Marcu, A., Marzano, M., Moseley, D., O'Brien, L., Randolph, S.E., Taylor, J.L., Uzzell, D., 2011. Frameworks for risk communication and disease management: the case of Lyme disease and countryside users. Phil. Trans. Biol. Sci. 366, 2010–2022.
Reed, D.B., Claunch, D.T., 2017. Moving social work norms via theater for senior farmers. J. Saf. Res. 60, 17–20.
Reicher, S., Stott, C., Cronin, P., Adang, O., 2004. An integrated approach to crowd psychology and public order policing. Polic. An Int. J. Police Strategies Manag. 27, 558–572.
Shortall, O., Brown, K., 2020. Enacting and resisting biosecurity citizenship: more-than-human geographies of enrolment in a disease eradication scheme in Scotland. Environ. Plann. E: Nature Space 4 (2), 564–584, 2514848620923590.
Shortall, O., Sutherland, L.-A., Ruston, A., Kaler, J., 2018. True cowmen and commercial farmers: exploring vets' and dairy farmers' contrasting views of 'good farming' in relation to biosecurity. Sociol. Rural. 58, 583–603.
Soleri, D., Cleveland, D.A., 2005. Scenarios as a tool for eliciting and understanding farmers' biological knowledge. Field Methods 17, 283–301.
Sunstein, C.R., Ullmann-Margalit, E., 1999. Second-order decisions. Ethics 110, 5–31.
Tewdwr-Jones, M., Wilson, A., 2022. Co-designing urban planning engagement and innovation: using LEGO® to facilitate collaboration, participation and ideas. Urban Planning 7 (2), 1–10. https://doi.org/10.17645/up.v7i2.4960.
Thaler, R., Sunstein, C.R., 2008. Nudge: Improving Decisions about Health, Wealth, and Happiness. Yale University Press, New Haven.
van der Heijden, K., 1996. Scenarios: the Art of Strategic Conversation. John Wiley, Chichester.
Vanclay, F., Enticott, G., 2011. The role and functioning of cultural scripts in farming and agriculture. Sociol. Rural. 51, 256–271.
Vial, F., Miguel, E., Johnston, W.T., Mitchell, A., Donnelly, C.A., 2015. Bovine tuberculosis risk factors for British herds before and after the 2001 foot-and-mouth epidemic: what have we learned from the TB99 and CCS2005 studies? Transboundary and Emerging Diseases 62, 505–515.
Wheeler, R., Lobley, M., Winter, M., Morris, C., 2018. "The good guys are doing it anyway": the accommodation of environmental concern among English and Welsh farmers. Environ. Plann.: Nature and Space 1, 664–687.
Whitehead, M., Jones, R., Lilley, R., Howell, R., Pykett, J., 2018. Neuroliberalism: cognition, context, and the geographical bounding of rationality. Prog. Hum. Geogr. 43, 632–649.