Badger Vaccination: Dimensions of Trust and Confidence in the Governance of Animal Disease

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Key Words:

Vaccination; trust; confidence; animal disease; governance; biosecurity; bovine tuberculosis; wildlife; badgers

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Abstract

This paper examines farmers' trust in badger vaccination as a method of preventing the spread of bovine tuberculosis (bTB) between wildlife (specifically badgers) and cattle in England. The spread of bTB has economic and social implications for farmers, but previous research has found that lack of trust in Government is a key factor in farmers' failure to adopt new preventative biosecurity practices. In these and other studies, however, the conceptual dimensions of trust are frequently loosely defined, meaning that it is unclear how trust, along with other factors, are related to the acceptance of new biosecurity practices such as vaccination. Drawing on findings from a telephone survey of 339 farmers and in-depth interviews with a sub-sample of 65, the paper explores attitudes towards, and levels of acceptance of, badger vaccination amongst farmers across five study areas with varying levels of bTB disease. Results reveal low levels of trust in both Government to manage bTB and confidence in badger vaccination. Principal components analysis identifies three specific dimensions of trust which, along with farmers' perceived self-efficacy, the perceived threat of disease and faith in others to manage disease, are all significantly related to the acceptability of badger vaccination.

1. Introduction

Trust is a key factor in the public acceptance and confidence in new methods and techniques to resolve environmental risks. Studies of public attitudes to genetically modified crops, nuclear power and climate change reveal low levels of trust in science and the Government (Poortinga and Pidgeon, 2003; Poortinga and Pidgeon, 2005; Wynne, 1992). In public health, trust has also been shown to be particularly influential in determining the uptake of vaccines (Casiday et al., 2006; Smith et al., 2007). In the governance of animal disease, lack of trust in Government – that is policy makers, government departments and those responsible for policy implementation – is seen as a key factor in explaining farmers' lack of confidence in and resistance to biosecurity practices to help prevent disease (Enticott, 2008a; Fisher, 2013; Poortinga et al., 2004). However, studies of environmental risks frequently fail to acknowledge that trust is multi-dimensional, specify which dimensions of trust they are referring to, and/or conflate trust with other concepts such as confidence (Metlay, 1999). This means that it is unclear how trust – as well as other factors – is related to the public acceptance of new methods of managing environmental risks.

Attempts to move beyond loose definitions of trust have focused on the public's attitudes to a range of common environmental risks (Poortinga and Pidgeon, 2003). This paper takes a different approach. Firstly, it focuses on new attempts to limit the spread of animal disease. Social studies of animal disease have grown in recent years, in part because like other environmental risks animal disease can have serious social and economic consequences (see Convery et al., 2005, for example). Secondly, rather than focus on the general public, the paper pays attention to the dimensionality of trust amongst farmers. Whilst farmers are key decision makers for animal health, the adoption of biosecurity practices depends on the extent to which

they resonate with farmers' social and ecological landscapes (Panter-Brick et al., 2006). Thus, in seeking to understand the nature and impact of trust upon animal disease management techniques, this paper contributes to an attempt to show where and how animal disease governance can be improved and avert the socio-economic impacts of animal disease.

The paper draws upon a case study of bovine tuberculosis (bTB) in England and attempts to reduce transmission to cattle by vaccinating wild badgers. The disease results in the annual slaughter of 35000 farmed cattle and costs the taxpayer £100 million per annum (Defra, 2013). The involvement of badgers makes for a challenging policy arena as they are protected by law and culturally iconic such that traditional solutions – such as culling badgers – are controversial (Enticott, 2001). Vaccination therefore provides a potential solution to public opposition to badger culling and scientific debates over its role and efficacy. In contrast to previous qualitative studies of farmers' attitudes to animal disease, the paper investigates these issues using a mixed methodology involving a survey of farmers and in-depth interviews in the West and South-West of England. The paper begins by describing the relationship between animal disease, trust and confidence; it then provides methodological details before describing how dimensions of trust influence farmer acceptability of badger vaccination.

2. Vaccination, Trust and Animal Disease

Explanations of health behaviour typically seek to identify key factors that influence the decision to adopt particular disease prevention interventions such as vaccination. In human health, the Health Belief Model (HBM), developed by Hochbaum (1958), has been particularly influential in attempting to explain vaccination decisions. The HBM suggests that a range of factors influence such decisions, including: perceived

susceptibility to disease, perceived severity of disease, perceived benefits of vaccination, and perceived barriers to vaccination (see for example, Evans and Watson, 2003). The HBM is closely aligned with other psychological theories of action such as Theories of Reasoned Action and/or Theories of Planned Behaviour (see Fishbein, 2000). The concept of self-efficacy has also been used to explain health behaviour. This refers to people's perceptions of their ability to complete a course of action or the extent to which they feel their health to be in their control rather than subject to luck or unavoidable events. For example, Raithatha et al. (2003) show that when vaccination is perceived to be an easy process, it is more likely to occur. More broadly, Davison et al (1991) chart the cultural significance of chance as a reason not to take preventive health measures. Alongside these factors, Panter-Brick et al (2006) suggest that for health interventions to be effective, they need to be culturally compelling, culturally appropriate and demonstrably effective. Accordingly, 'the design of health interventions must nestle within the social and ecological landscape of local communities' (ibid. p.2810). Trust is an important part of this landscape, with Brownlie and Howson (2005) showing how vaccine acceptance is related to the legitimacy of the state; anxieties about techno-scientific and social change; and health professionals' own inter-personal relationships.

The significance of trust is also apparent in attempts to explain farmers' adoption of disease prevention initiatives. Firstly, interventions may be trusted because messages of effectiveness can be adapted to fit with culturally held beliefs about the aetiology of animal disease and culturally accepted methods of appropriate farming. For example, Heffernan et al. (2008b) reveal how the uptake of vaccination for Foot and Mouth Disease (FMD) in Bolivia related to the ways in which discourses of vaccination could be 'reinvented' and matched to trusted local cultural beliefs about disease. In this context, vaccination was not trusted because of scientific discourses of efficacy and economy, but because farmers understood FMD to be caused by

heat, whilst vaccination worked by 'cooling' animals. In short, farmers' cultural health beliefs provided the basis for vaccination acceptability rather than trust in scientific experts.

Secondly, whilst the adoption of disease prevention methods may be influenced by cost, information and practical considerations (Elbers et al., 2010), it may also be related to levels of trust between farmers and members of local social networks. In their study of E-coli prevention, Ellis-Iversen et al (2010, p.283) argue, for instance, that farmers with no intent to control disease needed a 'trusted source to advise them to implement control before they would consider any action'. These inter-personal and community based forms of trust are also important in relation to the management of bTB. Enticott (2008a) shows how lay epidemiologies of disease are constructed from shared local experiences of disease of other farmers. The failure to control disease or implement biosecurity practices is legitimized by community held views of appropriate farming behaviour. Similarly, Fisher (2013) describes how levels of trust between a farmer and an advisor have an important influence on whether biosecurity advice is followed.

Thirdly, lack of trust in distant agencies and actors may influence the adoption of biosecurity measures. According to Enticott (2008a,b), one reason why local knowledges of bTB are trusted by farmers is due to their alienation from scientific studies designed to examine the spread of bTB. At the same time, lack of trust in the Government is accentuated by its failure to respond to farmers' concerns over bTB and its perceived incompetence to manage other animal disease issues such as FMD. Similarly, Heffernan et al's (2008a) analysis of farmers' perceptions of biosecurity finds that a lack of collective support, belief in the Government's responsibility and poor understandings of farming amongst Government are barriers to biosecurity implementation. However, whilst the lack of institutional trust appears

to be important, trust in the institution of Government can simultaneously remain high. This is because, as a collective endeavour, biosecurity requires the complicity of all concerned: free-riders undermine efforts of the wider community. In contrast to the role of local trust in shaping biosecurity practices, Gunn et al (2008, p.320) suggest that 'farmers, veterinarians and the auxiliary industries appeared to lack trust in each others' motivation or ability to maintain adequate biosecurity at farm level'. Similarly, Heffernan et al. (2008a) suggest that farmers are distrustful of each other's intentions to implement disease control measures, so preventing broader collective action against the spread of animal disease. In this context, farmers remain supportive of government actions and, despite their reservations, call for greater regulation to ensure biosecurity practices are followed by everyone.

Whilst trust in local and national actors and agencies appears to be a key factor influencing confidence in vaccination, the concepts of trust and confidence are frequently ill-defined. In human health research, vaccine confidence is broadly understood as either the intention to vaccinate or actual vaccination. Similarly, trust is used to refer to a general attitude towards the Government or other party. These descriptions efface their multi-dimensional nature and provide a partial account of the ways in which trust contributes (or not) to the control of animal disease. Various authors have argued that trust is a multi-dimensional concept. Renn and Levine (1991) identity five core components: perceived competence, objectivity, fairness, consistency and faith. Kasperson et al. (2003) suggest four components: commitment, competence, caring and predictability. However, Metlay (1999) argues that these attempts to classify trust are overcomplicated and conceptually dubious. This is supported by Siegrist et al. (2003; 2005) who argue that trust and confidence are two separate constructs. Trust is based on 'shared values [and] judgment of similarity between one person and another' (Siegrist et al., 2003: 706). Confidence is defined as 'the belief, based on experience or evidence, that certain future events will

occur as predicted' (ibid.), whilst the key distinctions between trust and confidence are: 'trust involves risk and vulnerability, whereas confidence does not; trust is based on social relations, whereas confidence is based on familiarity; the objects of trust are person-like entities, but one can have confidence in just about anything' (ibid.).

Subsequent research has sought to analyse the relationship between trust and confidence. Various authors have attempted to isolate different dimensions to these constructs, but generally find that trust is related to just two core factors: general trust and general competence (confidence). For example, Metlay (1999) analyses trust and confidence in relation to the following dimensions: openness, reliability, integrity, credibility, fairness, caring, and competence. However, principal components analysis shows that overall only two components can be identified. The first component relates to affective elements of trust (reliability, integrity, credibility, fairness and caring); the second component relates to institutional competence. Poortinga and Pidgeon (2003) find similar results in relation to a range of different environmental risks. Like Metlay, they also identify two components: the first is labelled, 'general trust' which relates to competence, care, fairness and openness; the second – 'scepticism' – relates to credibility, reliability and integrity. Analysis of food-related risks by Frewer et al (1997; 1996) also finds two trust components: the first component, general trust, included aspects of care and competence; the second related more to a vested interest/accountability factor.

Research on environmental risk therefore identifies two key axes of trust. The first is a general affective assessment of trustworthiness. General levels of affect are increasingly recognised as a core element of lay perceptions of risk issues (Slovic et al., 2004; Finucane et al., 2000). General trust tends to apply to an institution as a whole, but Poortinga and Pidgeon suggest that there are different levels to trust which may lead to more differentiated perceptions. The second element of trust

relates more to competence and credibility, or scepticism, which can have affective qualities. The extent to which similar dimensions of trust can be identified in arguments over the governance of animal disease and influence confidence in animal health vaccines is, however, untested.

3. Methodology

In 2009, the Department for Environment, Food and Rural Affairs (Defra) announced that badgers were to be vaccinated in six areas of England as part of a Badger Vaccination Deployment Project (BVDP). The aim of the project was to test the practicality of badger vaccination, build confidence in the principle of badger vaccination amongst farmers and develop a market amongst pest controllers to provide vaccination services to farmers and wildlife groups (Defra, 2009). Vaccinators would be trained by the Government and could be professional pest controllers or lay vaccinators – usually members of wildlife conservation groups. Following the election of the coalition Government in 2010, the BVDP was reduced to one 100 km² area near Stroud (Gloucestershire). Whilst the aim of increasing confidence in badger vaccination amongst farmers remained, there was limited understanding of farmer confidence in bTB vaccines. Prior to the development of the vaccine, research suggested farmers' confidence levels were low (Bennett and Cooke, 2005), but little was known about what constituted trust and confidence in badger vaccination or the factors and barriers that could influence farmers' future use of bTB vaccines. The aim of this study was therefore to examine and establish levels of farmer confidence in badger vaccination and identify factors influencing its use.

A mixed-methods approach was adopted involving a survey, interviews with farmers and participant observation of badger vaccination. This paper reports only on the farmer survey and face-to-face interviews (see also Enticott et al. 2012 and Maye et

al. 2013). The survey was conducted in five case study areas in England: Stroud (the BVDP area) and four non-BVDP areas (see figure 1). All are areas of high bTB incidence, but bTB is less pronounced and more recent in south-east Congleton. Cheltenham and Tetbury were selected because of close proximity to the BVDP area. The remaining two areas (Congleton and Torrington) were chosen because of differences in bTB prevalence and attitudes towards badger vaccination established from farmer meetings about the BVDP.

A sample of farmers was drawn using farm characteristics data (farm size, farm type) and BVDP membership (for Stroud) using the Animal Health and Veterinary Laboratories Agency (AHVLA) VETNET database, which contains details on farm characteristics and disease history. The sample was weighted to reflect the total number of farms per area, farm type and farm size. The survey contained 56 items and took approximately 20 minutes to complete. It was organised into three sections containing mostly five point agree-disagree likert-scale type questions and opportunities for respondents to provide additional comments. The survey included 31 different statements on trust in Government used in previous research by Metlay (1999) and Poortinga and Pidgeon (2003). The statements were adapted to reflect the context of badger vaccination and bTB. Respondents were specifically asked to reflect on 'the Government' as a whole, rather than individual departments, actors or agencies. Farmers were also asked a series of general questions about their confidence in badger vaccination, its general acceptability, and an affective evaluation of badger vaccination. The survey also drew on models of health behaviour in human and animal health. Survey items on the benefits and risks of badger vaccination, and the severity and susceptibility of farmers to bTB, were derived from the Health Belief Model. Survey items relating to farmers' perceived control of bTB (i.e. their self-efficacy) and farmers' faith in others to provide solutions to bTB were also included.

- INSERT FIGURE 1 HERE -

Following a pilot, the survey was conducted by telephone in Autumn 2010. A total of 339 usable responses was collected, representing a response rate of 80% (78 farmers refused to participate because of a lack of time, knowledge of badger vaccination, and/or retirement from farming). Analyses of bTB statistics from the VETNET database revealed no statistically significant differences between participating and non-participating farmers. The survey sample represents 27% of the total population of the case study areas and is thus representative in terms of farm type. The majority of respondents (58%) were beef farmers, male (83%) and farmed an average of 100 hectares. 61 farms (18%) had bTB at the time of the survey, but this varied regionally: in Torrington 25% of farms were infected, compared to only 8% in Congleton. In Stroud, 37 (47%) were participating in the BVDP. Issues raised in the survey were further explored in interviews with 65 of the 339 surveyed farmers in Autumn 2011. This included asking farmers more detailed questions to understand the factors that influence confidence levels in badger vaccination as a bTB control method. Interviews took place in three of the survey locations (Stroud, Great Torrington and Congleton) to account for different levels of disease and exposure to badger vaccination. Farmers were sampled according to their levels of trust in Government and confidence in badger vaccination (see Enticott et al. 2012 for further details). Twenty farmers were interviewed in Stroud (14 of whom were in the BVDP), 22 in Congleton and 23 in Great Torrington. Most interviewed farmers owned their farms (33); were male (57); and were aged between 40-54 (30); 25 were aged over 55. In total, 37 farmers had beef herds, 26 dairy and two were mixed farms. Most interviewees (44 out of 65) had experienced a bTB outbreak in the previous five years and 16 were infected at the time of the interview.

All telephone survey responses were directly entered into an Access database and exported to SPSS for analysis. Data have been analysed using a range of single and multi-variate analysis. Principal components analysis was used to combine survey items where appropriate. Ordinary Least Squares (OLS) regression was also used to analyse the determinants of badger vaccine confidence. Farmer interviews were audio recorded and transcribed. Interview transcripts were imported into NVivo9 and coded for analysis.

4. Results

This section begins by describing farmers' attitudes towards bTB. Dimensions of trust amongst farmers are identified before considering the extent to which they influence confidence in badger vaccination.

4.1 Health Beliefs about Bovine Tuberculosis and Badger Vaccination

Most (86%) respondents said that the impact of bTB would be a big problem for their business, whilst 76% believed their herd was susceptible to bTB because of badgers close to their farm. Underlying these concerns was the belief amongst farmers that they were unable to do anything about bTB. Most farmers believed they could do nothing to prevent it and did not believe that following advice from vets or copying what other farmers did would reduce their chances of getting bTB. For example:

> "It is really frightening, because we can't control it. It has nothing to do with our good husbandry, whereas all the other diseases cattle have, you can help them or prevent it. But you can't do a thing with TB... If it sneaks up on you, it gets you... It is something we are very frightened about"
> (Female farm partner, Congleton, 380 cattle, mixed farm).

As a result, many (79%) farmers surveyed felt that it was simply a matter of luck if their herd tested positive for bTB. Farmers described bTB as "like lightning striking…it might get you, it might not" or simply a "lottery".

In spite of the lack of firm evidence that badger vaccination can subsequently reduce bTB in cattle, 45% of farmers thought that badger vaccination would reduce bTB in cattle. However, more nuanced understandings of vaccination were expressed in interviews. Some farmers felt vaccination would probably reduce bTB in cattle at some level, and thus did not disagree in principle with vaccination. However, many had significant misgivings about the widespread use of vaccination to control bTB. Farmers did not believe that badger vaccination posed a particular risk to their business. One risk might be that vaccinating badgers may disturb badger social groups and lead to a spread of disease. One farmer in Stroud suggested that this might have been the cause of a recent bTB breakdown on his farm, but in general farmers saw vaccination as a benign activity that was beset by practical problems. The practicalities of vaccination and its cost were frequently raised by farmers in interviews:

> "I don't see how you would even manage to vaccinate 50% of them. A terrific job. Only thinking about our woods and our setts…How would you get them all?" (Male farmer, mixed tenancy, Congleton dairy farm, 300 cattle).

These views were also borne out in the telephone survey, with a majority of farmers (60%) stating that it was impractical to vaccinate badgers.

4.2 Farmers' Trust in Government

Over three-quarters of farmers in the survey felt that bTB regulations had been insufficient to prevent its spread, with dairy farmers feeling least confident. In terms of the Government's credibility, one-third of respondents thought the Government distorted the facts about bTB, and a similar number thought that the Government had

ignored the views of scientists who disagreed with them about bTB. Just over 50% of farmers did not believe the Government were doing a good job in relation to bTB, and less than one third of farmers agreed that the Government acknowledged the mistakes it had made about bTB. These attitudes were reflected throughout the interviews. There was an almost universal response that bTB had been poorly managed over the last few years:

> "I think they have wasted a lot of money. They could have done something before. They should have started doing things before because it's costing the country a lot of money" (Male farm owner, Great Torrington, 156 cattle, beef fattening farm).

Respondents felt that the Government should have taken more active responsibility. A small number of farmers expressed a general lack of enthusiasm for 'official' bTB policy. As one farmer, who had lost over 50 cattle to TB, put it:

> "It just goes on and on and on, I know this is poor and maybe I haven't got the staying power, but I just get bored of hearing the same old arguments with not a lot going on ever" (Male farmer, mixed tenancy, Great Torrington, bTB infected, 350 cattle dairy herd)

As a result, a high proportion of farmers doubted that the Government could conduct badger vaccination competently.

In terms of the reliability of the Government, farmers offered some consensus that the Government took its commitment to reducing bTB seriously, although 27% disagreed with this statement. Farmers suggested that the Government cared about reducing bTB and was interested in what farmers think about badger vaccination. Similarly, a majority of farmers felt that the Government considered all arguments for and against badger vaccination. However, far fewer felt that decisions made by the Government were fair and just. Instead, farmers judged the fairness of regulation in the light of the Government's (in)action of dealing with bTB. For example:

> "We've had rules put in place that we have adhered to, and they have promised to do something with the badgers and then it all gets puffed away and kicked around and nothing happens" (Male farmer, mixed tenancy, Congleton dairy farm, 300 cattle).

This implies a distinction between the way farmers consider the Government's general attitude towards bTB, which tends to be positive, and statements that focus on how the Government translates that general attitude into policy to deal with the bTB problem, which in their mind is not always fair or just. Overall, responses suggest farmers do not trust the Government to manage bTB policy or vaccination, although many were unsure given that bTB policy as a whole was (and continues to be) in a state of flux.

4.3 Acceptability of Badger Vaccination

Farmers were asked to score three statements about the *general acceptability* of badger vaccination. Results reveal a clear split in opinion: 40% agreed vaccination was acceptable, but the same proportion disagreed. More farmers disagreed (60.7%) that vaccinating badgers was better than culling badgers to control bTB, suggesting that respondents generally felt that badger vaccination was not the best way to control bTB, although many deemed it was acceptable as part of a wider control strategy. For example, many farmers viewed vaccination as a strategy that could work alongside badger culling, suggesting that vaccination should be used to help protect 'healthy' badgers from infection whilst diseased badgers should be culled immediately. Narratives about nature and the health of the badger population emerged during interviews with farmers, who argued that the badger population was over-populated which had contributed to greater levels of infectivity amongst badgers. Where farmers distinguished between 'clean' and 'dirty' (or infected) badgers, farmers with 'clean' badgers said they protected them believing – as badgers are territorial – they would protect them from 'dirty' badgers infecting their cattle. In both cases, these beliefs explain why many farmers felt badger vaccination alone would not work: either it would not affect the problem of the *population* or

vaccination could not solve the problem of 'dirty' badgers as vaccines do not work on badgers already infected.

Farmers were also asked for their opinions regarding the *general effectiveness* of badger vaccination. Almost half of the respondents agreed that vaccination was a good thing to do. However, few respondents had high levels of confidence in the integrity of the Government. Four out of every five respondents felt the Government was too influenced by public opinion regarding badger vaccination. In interviews, farmers frequently remarked that the bTB policy was:

> "all too political, it isn't a vote winner. The general public doesn't like it. People would rather see cattle killed than badgers"
> (Male farm partner, Stroud, 400 cattle, beef fattening farm, part of the BVDP).

Nevertheless, the general feeling was that responsibility for dealing with the disease lay with the Government, with almost 90% of respondents agreeing that paying for badger vaccination should be the Government's responsibility.

Only a quarter of farmers were confident that badger vaccination would help prevent the spread of bTB. Partly, this was attributable to farmers' lack of engagement with badger vaccination: in areas where vaccination was occurring such as the BVDP, farmers generally had more positive views. Farmers' confidence in badger vaccination did not seem to vary according to location, farm type or disease history. Lack of confidence in badger vaccination was also attributable to the lack of evidence that badger vaccination was effective. As one farmer put it:

> "If I knew it worked, I would agree with it. But until somebody tells me it works, or shows me, then I won't agree. We've got to know what we are letting ourselves in for"
> (Male farm partner, Congleton, 50 cattle, beef suckler farm).

4.4 Determinants of Confidence in Badger Vaccination

In order to assess the extent to which different factors affected farmers' views of badger vaccination, an index of vaccine acceptability was developed using eight items from the survey. Items related to vaccine acceptability, farmers' general affective evaluation of badger vaccination, and their perceptions of the risks and benefits of badger vaccination. These items have strong internal reliability (Cronbach's Alpha 0.907), meaning they are suitable for combining into an index. Values for each item were combined in a summative index ranging from a minimum value of 8 (minimum acceptance of badger vaccination) through to 40 (maximum acceptance). The mean value for the index was 23.325 (minimum: 9.25; maximum: 39; Standard Deviation: 6.16).

Independent variables were developed using principal components analysis (PCA). Firstly, the 14 variables on trust and confidence in badger vaccination were entered into the PCA. As stated above, these variables covered 7 different aspects of trust, yet previous analyses reveal just two over-arching trust and confidence components (Poortinga and Pidgeon, 2003; Metlay, 1999). Results from this PCA echo these previous studies, but with some slight variation (see table 1). In total, three components explain 59% of the variance in the variables. The first component is dominated by two 'care' statements relating to the Government caring about reducing TB and being interested in what farmers think about badger vaccination (Eigenvalue – 5.809; % variance – 41.490). The component also loads significantly on aspects of integrity, fairness, reliability and competence. This component is interpreted as relating to the Government's *commitment* to resolving problems associated with bTB. The second component is more directly related to aspects of the Government's *competence* and is interpreted as such (Eigenvalue – 1.292; % variance – 9.228). The third component loads onto aspects of the Government's credibility and integrity (Eigenvalue – 1.161; % variance – 8.292). This component is interpreted as relating to farmers' *scepticism* towards the Government's approach to bTB.

These three trust components were included in an OLS regression to determine the extent to which they determined farmers' acceptability of badger vaccination. In addition, PCA was used to combine variables relating to farmers' perceived health beliefs of badger vaccination. Three separate factors were included: threats and susceptibility of bTB; self-efficacy and control beliefs of bTB; and the role of influential others (such as vets). Contextual variables were included to reflect each farm's disease status and history; herd size and type; and whether their farm was part of the BVDP.

Results from the OLS regression (see Table 2) indicate the variables explain 37.1% of the variance in the data (adjusted R^2 0.371). Six out of eleven variables were statistically significantly correlated with farmers' acceptance of badger vaccination. All three trust variables are significantly related to the dependent variable. *Competence* and *scepticism* are strongly positively associated with badger vaccination acceptability. Farmers who believed the Government to be *competent* are therefore likely to accept badger vaccination. By contrast, the *commitment* variable was negatively associated. Farmers who thought that the Government was not committed to resolving bTB were less enthusiastic about badger vaccination.

The remaining variables significantly associated with badger vaccination acceptability were all linked to farmers' health beliefs. Farmers who did not feel themselves to be under threat from bTB were more likely to be accepting of badger vaccination. However, there was no relationship between a farmer's bTB status and their bTB history since 2003. Similarly, herd size and dairy herds were not related to acceptance of badger vaccination, but are factors associated with bTB risk (Independent Scientific Group (ISG). 2007). In other words, acceptance of badger vaccination is associated with perceived risks and impacts of bTB, but not objectively

defined risk factors. The interview findings support this general view. Farmers assessed badger vaccination in relation to wider beliefs about nature as much as farm-based factors. The OLS regression also suggests that farmers with low self-efficacy have low confidence in badger vaccination. That is to say that farmers who believe that bTB can be prevented by following the advice of vets and neighbouring farmers are also more likely to have greater levels of confidence in badger vaccination.

- INSERT TABLES 1-2 HERE -

5. Discussion

These results provide confirmation of previous analyses of the nature of trust and confidence, as well as raising questions for the way bTB can be managed in future. Firstly, the results provide confirmation of the meaning of trust but in a different context to previous research findings. Results from the PCA were consistent with those recorded by both Poortinga and Pidgeon's (2003) and Metlay's (1999) analyses of trust in environmental risk regulation. The three components identified in this study explain 59% of the variance in the variables, which are similar values to those recorded by Poortinga and Pidgeon (2003). The first component from the PCA (Eigenvalue: 5.809) explains 41.5% of variance. The remaining components were lower but of similar values (1.292 and 1.161) explaining approximately 9% of the variance each. Again, these compare well with findings from previous research. Poortinga and Pidgeon reported Eigenvalues of 4 – 4.83 for the first component, explaining between 37-44% of variance; and 2.1-2.7 for the second component, explaining between 19-25% of the variance. Similarly, Metlay's work identified two components: the first had an Eigenvalue of 9.57 and the second of 1.027 (variance %'s are not given).

Results from this PCA therefore fall broadly in line with previous attempts to determine the dimensionality of trust. When farmers are asked about their trust in the Government's handling of animal health, their concept of trust is analogous to the public's views on other environmental risks. Like Metlay and Poortinga and Pidegeon, farmers identify trust in general terms, referring to the Government's commitment and care, although not its credibility. Moreover, like Metlay, competence emerges as a key component of trust. Finally, like Poortinga and Pidgeon (but not Metlay), scepticism emerges as a distinct component. Overall then, this research finds that, in the context of animal disease, the components of trust are not significantly different to other environmental risks. Results are loaded more towards commitment as a form of trust, but scepticism and competence are also distinguishable.

Secondly, results support findings from previous qualitative research relating to the management of bTB. Farmers' lack of trust in the Government's competence to manage bTB reflects directly upon their lack of confidence in badger vaccination. However, farmers who reject vaccination rate the Government's commitment to bTB higher. This reflects wider political changes at the time of the survey. Before the telephone survey, the Conservative-led coalition Government announced plans to allow farmers to cull badgers to control bTB. This strategy reflected farmers' own beliefs about controlling bTB, as well as closer political ties between farmers and the Government, and helps to explain why farmers' perceptions of the commitment of the Government is negatively associated with vaccine confidence. In interviews, farmers commented that in general the disease had become 'too political' because '[politicians] are afraid for their lives of losing one vote". Nevertheless, farmers balanced these views with the changing political colour of the Government that they were "prepared to give this Government a go" because of its change in attitude to

bTB “compared to the last lot”. These comments suggest how trust in the Government can change according to broader changes in the political environment, rather than the Government’s actions *per se*. They also reinforce the need for studies to distinguish between different forms of trust as its constitutive concepts may be related in different ways.

These results also confirm the relationship between farmers’ self-efficacy and the adoption of bTB management tools. In relation to other bTB control measures such as biosecurity and husbandry techniques, Enticott (2008a) suggests that farmers’ experiences and observations and/or knowledge of other farmers’ bTB breakdowns lead them to conclude that these interventions do not work. Instead, farmers believed disease to be down to luck: their perceived inability to control circulations of badgers and bacteria across their land, and the uncertainties and limitations inherent to bTB diagnostic tests for cattle, led them to believe they had no control over bTB with the consequence that they became fatalistic about preventive forms of bTB management. The results from this study provide further confirmation of farmers’ perceived lack of self-efficacy. In this study, farmers expressed similar concerns over the accuracy of the bTB test which meant that getting bTB was like a lottery. The role of luck was heightened further by the presence of ‘dirty’ badgers that were either undetectable or for whom the absence of methods to reduce the badger population meant that infection was a matter of time and beyond their control. Importantly, this belief in lack of self-efficacy was related to farmers’ confidence in badger vaccination. Farmers who believed bTB was a matter of luck had little faith in badger vaccination. Rather, it was only farmers who believed they could do something to stop bTB that were confident in badger vaccination.

For policy makers, the lesson from these results is therefore that the acceptability of badger vaccination is dependent on farmers feeling confident that bTB is a disease

that can be controlled effectively. Attempts to improve confidence frequently revolve around the publication of scientific evidence in a deficit-style manner of scientific communication. For this strategy to work, however, robust scientific information is required. Yet, the effectiveness of badger vaccination is unproven and, whilst experimental data suggest that vaccinated badgers are less likely to become infectious (Chambers et al., 2011), there are no field trial data that link badger vaccination with a reduction in cattle bTB. Even if such data existed, the success of attempts to improve farmers' feelings of self-efficacy by providing them with scientific information on the effectiveness of badger vaccination might be a flawed strategy. This is because farmers' beliefs about nature and disease appear at odds with the aims of badger vaccination. During the telephone and personal interviews, farmers frequently remarked that, whilst they liked to see badgers and were not 'anti-badger', there 'were too many badgers' and the 'population was out of balance with nature'. The abundance of badgers and their connection with disease, despite their continued protected status, were contrasted with the way badger numbers had been historically kept low prior to the Protection of Badgers Act. For example:

> "We've got nothing against the badger, but we don't want the TB. Farmers are keen on wildlife. People shouldn't be badger baiting but in terms of agricultural control, they shouldn't be a protected species".
> (Female farm owner, Stroud, 250 beef cattle, not part of the BVDP)

Elsewhere, these beliefs in over-abundance and natural balance are strongly linked to the acceptance of specific types (i.e. lethal control) of wildlife management techniques (Dandy et al., 2012; Eden and Bear, 2011). Thus, whilst policy makers may see these results as indicative of the need to address farmers' self-efficacy, this may only be achieved through the adoption of wildlife control strategies that meet farmers' concerns about nature rather than specifically disease. In short, farmers' confidence in badger vaccination is dependent on other disease control measures being used that address specific philosophical concerns about nature.

Thirdly, and relatedly, the results show that perceptions of bTB risk, rather than objective measures of risk, impact upon farmers' confidence in badger vaccination. Previous research has suggested that the greater the threat from disease, the more likely it is that people want action to be taken to prevent disease. However, in this case, there appears to only be a connection between badger vaccination and the perceived threat of bTB. The absence of correlation between vaccine acceptability and each farm's disease history may be because farmers perceive risk at a different spatial scale, drawing on not just their own bTB histories but those of their neighbours as well. Thus, in accounting for their bTB 'biographies', farmers would cite the constant threat of disease as it travelled and circled through their locality. The apparent randomness of the disease in their locality meant they were always at risk, regardless of their own bTB status. This was a view expressed by some farmers in the interviews. The lack of relationship between actual bTB incidence and confidence in badger vaccination does not mean that farmers are not keen to prevent the disease. Rather, as indicated above, rejection of badger vaccination may be related to farmers' own beliefs about nature and the ability of other control measures, such as culling, to deal effectively with the disease in badgers.

This relationship between perceived and actual bTB risk is also relevant to the future of badger vaccination policies. One problem facing policy makers has been deciding which locations offer the most effective use of badger vaccination. Defra's (2013) bTB strategy suggests that badgers in low incidence areas should be vaccinated to act as a firewall and prevent bTB spreading from endemic areas. However, demonstrating the impact of the use of vaccine in these areas would be difficult. Another school of thought suggests that the most value from vaccination would be gained in areas of high bTB prevalence. Although the prevalence of the disease in badgers in these areas could be higher and the vaccine could therefore have no effect at all, evidence from vaccination studies suggests a greater protective benefit

to badger cubs which could be enhanced through repeat vaccination and turnover in the badger population (Carter et al., 2012). However, with the Government intent on passing on the costs of wildlife control to the agricultural industry, the results of this study suggest this is only likely to be successful (if at all) in areas where farmers believe bTB is not a threat to their business. Amongst these farmers, confidence is highest. It is not known whether these farmers are prepared to pay for vaccination for the benefit of other farmers: currently there are no examples of farmer-led vaccination campaigns in either high or low risk areas. The lack of trust and philosophical differences in the need for wildlife control may mean that policy makers would be better off encouraging wildlife groups rather than farmers to undertake badger vaccination.

Finally, these findings provide confirmation that farmers' trust in Government is both low and directly related to farmers' acceptance of different control methods. The results provide further confirmation of the social basis for the acceptance of new biosecurity techniques. Studies of agricultural extension (Pannell et al., 2006) have shown that the adoption of agricultural technologies is shaped by the social milieu of farmers. In animal health too, advisers such as vets have been shown to be highly trusted, if not always frequently used (Gunn et al., 2008). Farmers in this survey who followed their vet and/or farming friends' advice were also more likely to have confidence in badger vaccination. The development of high levels of social capital between farmers and their advisors, therefore, offers one way through which farmers can be encouraged to adopt specific biosecurity techniques (Fisher, 2013).

6. Conclusion

This paper analyses the relationship between farmers' trust in Government and their confidence in animal disease interventions. Previous qualitative studies of bTB have

concluded that farmers have low levels of trust in the Government which affects their adoption of specific control mechanisms. Frequently, however, these studies have failed to fully conceptualise what is meant by trust. This study addresses that gap and provides the first quantitative assessment of farmers' level of trust in the Government's bTB policy and, combined with qualitative data from face-to-face interviews, an insight into how trust and other factors affect farmers' confidence in badger vaccination.

The results show that farmers identify three different components of trust – competence, commitment and scepticism – that are broadly analogous to previous analyses of the public's trust in other areas of environmental policy. Farmers have low levels of trust in Government and vaccine confidence. Lack of trust in Government and the threat of bTB are significantly related to the farmers' confidence in badger vaccination as a way of controlling bTB. Importantly, farmers believe there is little they can do to prevent bTB. Vaccination does little to alleviate these concerns. Instead, farmers who have low levels of self-efficacy are also likely to dismiss vaccination as a solution to bTB.

The findings have implications for the way Governments seek to manage animal diseases. Clearly, of prime concern to policy makers should be attempts to rebuild trust with farmers. The contentious nature of bTB means that this is no easy task: balancing public and private rights lies at the heart of this dispute. Restoring trust and credibility to bTB policy and its solutions may require a new way of constructing policy in which farmers come to own the management of the disease and have a direct stake in decisions that affect them. Whether such a solution can effectively be balanced against public interests is debatable. However, from these results it is clear, as Panter-Brick et al. (2006) acknowledge, that attempting to employ solutions that do not easily fit amongst the social and ecological landscapes of those affected by

bTB are unlikely to work effectively. For badger vaccination, the evidence presented here suggests that any fit is at best uncomfortable and that vaccination requires nestling amongst a range of other measures before farmers accept its use as a means to manage bTB.

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Table 1: PCA analysis of 14 trust variables				
Concept	Variable	Component loadings		
		1	2	3
competence	The Government is doing a good job in relation to bTB	**.617**	.356	.020
integrity	The Government acknowledges mistakes it has made about bTB	**.703**	-.074	.041
reliability	The Government takes its commitments to reducing bTB seriously	**.768**	.353	.099
care	The Government is interested in what farmers think about badger vaccination	**.549**	.314	.355
care	The Government cares about reducing bTB	**.729**	.111	.218
fairness	The Government considers all arguments for and against badger vaccination	**.562**	.416	.244
competence	The Government is organising badger vaccination competently	.319	**.780**	.113
competence	The Government has the necessary skilled people to manage badger vaccination	.069	**.799**	.130
reliability	We can rely on the Government to ensure that badger vaccination is carried out properly	.131	**.695**	.236
openness	The Government is open and honest about badger vaccination	.410	**.530**	.385
credibility	The Government does not distort the facts about bTB to make its case for badger vaccination	.169	.116	**.809**
credibility	The Government does not ignore the views of scientists who disagree with them about badger vaccination	.325	.110	**.756**
integrity	The Government is not too influenced by public opinion regarding badger vaccination	-.039	.230	**.607**
fairness	Decisions made by the Government about bTB are fair and just	.468	.411	.356

Table 2: Results of OLS regression

	Standardized Coefficients		
	Beta	**t**	**Sig.**
Trust 1: Commitment	-.103	-2.298	.022
Trust 2: Competence	.493	10.185	.000
Trust 3: Scepticism	.229	5.241	.000
Currently Vaccinating	.061	1.321	.187
Dairy herd or not	-.008	-.168	.867
No. cattle	.024	.457	.648
Current TB Status	-.040	-.781	.436
No. of all TB breakdowns since 2003	-.012	-.234	.815
Perceived threats from TB	-.102	-2.184	.030
Perceived TB self-efficacy	.140	3.172	.002
Faith in others to resolve TB	.146	3.136	.002