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Exploring the social context of risk perception and behaviour: farmers' response to bovine tuberculosis

Rhiannon Naylor and Paul Courtney

Abstract

While agricultural risk and perception of risk has received significant attention in the literature, few studies have explored the factors that influence the way farmers respond to particular risks. This paper uses the case of bovine tuberculosis (bTB), one of the most significant risks currently facing the English cattle farming industry, to explore these factors, with a particular focus on the role of social networks. A large scale postal survey distributed to beef and dairy farmers in the south west of England provides representative data which are subjected to multivariate analysis in order to explore farmer views towards and responses to disease risk. Two groups of farmers are identified which can be distinguished from each other based on their attitudes towards bTB and the nature of their social networks. Farmers with wider, more externally focussed social networks are found to be more resilient than those whose social networks are restricted to family members and other farmers. However, while differences between the two groups are found in terms of their attitudes towards bTB, no differences are found in relation to their risk management behaviour, with few farmers taking clear action to reduce the risk of their herds contracting the disease. In order to address the identified disconnection between attitudes and behaviour, a number of potential interventions are put forward and discussed.

Key words

Bovine tuberculosis; farmers; risk; segmentation; behaviour.

1. Introduction

Farmers continually make business decisions in a risky environment caused by significant uncertainty in relation to production (for example weather or disease), market anomalies and price fluctuations. Over the last twenty years, a diversity of strategies have been developed ranging from conversion to organic agriculture to nature conservation and agro-tourism in order to reduce the financial risks that are inherent in the industry (Oerlemans and Assouline 2004). In order to develop appropriate policy interventions, it is essential that the factors influencing the ways in which farmers approach risk and the choices they make in relation to

their response strategies, are understood. While there is a large body of literature on agricultural risk (see for example Hardaker et al., 2004; Cobel and Barnett, 2008), very few studies provide an in-depth discussion of the factors that influence how such risks are perceived and the factors that influence response to them. This paper aims to address this important research gap with a particular emphasis on the role of social networks. Building on an earlier paper (reference excluded to maintain anonymity) which presented an in-depth qualitative assessment of the relationship between social capital and farmer response capacity, this paper provides a quantitative analysis of a representative sample of farmers. The case study of bovine tuberculosis, one of the principle risks facing the cattle industry in England, is used to explore farmers' risk behaviour.

Bovine tuberculosis (bTB) is a bacterial disease found in cattle and other mammals throughout much of the world (Ayele et al. 2004; Schmitt et al. 2002). Its eradication is an international priority and has been successfully achieved in some countries, while others are making significant steps towards controlling the disease (such as New Zealand). However, in the United Kingdom (UK) the disease has spread significantly in recent years and the implementation of a range of control measures has not been successful in bringing the disease under control. Under European Union law, the UK is required to have a plan for the eradication of the disease (Council Directives 77/391/EEC and 78/52/EEC) and failure to meet minimum criteria poses a risk of infraction proceedings, financial penalties and trade sanctions. This study is therefore of international relevance in terms of exploring the issues and constraints associated with controlling bTB as well as disease control more generally.

The disease is currently having a major impact on cattle farms in England, particularly in the South West and West Midlands, and is now costing England over £100 million a year in compensation and costs associated with bTB testing. Since 2008, 30,000 cattle have been slaughtered annually due to the disease (Defra 2014). In cattle, bTB causes reduced productivity and premature death (Krebs et al., 1997), both of which have implications for wider farm productivity and the overall viability of the dairy and beef industries in the UK. Sustained disease outbreaks in livestock can also lead to problems associated with international trade agreements, should herds testing positive to bTB reach a critical level (Cousins, 2001).

Although the risk posed by bTB to farmers is well documented (Defra, 2013b; Butler et al., 2010; Johnston et al., 2005) there has been limited research into how farmers respond to it. In fact, very little social science research has been conducted in relation to bTB in general. The social science studies that do exist generally focus on farmers' attitudes towards disease control measures, particularly biosecurity (Enticott and Franklin, 2009; Enticott, 2008a; Bennett and Cooke, 2005). However, farmers' response to bTB is key to the implementation of successful disease control policies, particularly at a time when the government is emphasising cooperation and partnership working across government and the farming industry (Defra, 2013b).

Due to the limited social science literature on bTB it is useful to draw on the wider literature around risk, within which this study is usefully situated. This is provided in the following section. A discussion of farmer behaviour is then put forward. Following this, the methodology is presented followed by the results of an in-depth multivariate analysis of data collected through a large postal survey. The findings are then presented and the implications for understanding farmer disease response behaviour are discussed. A conclusion is provided in the final section.

2. The social context of farmer risk perception and behaviour

Farmers' responses to bTB are likely to be influenced by their perception of the level of risk that the disease poses. Risk is a complex concept which has received considerable interest from academics (see for example Beck, 1992; Hardaker et al, 2004, Botterill and Mazur, 2004). The reaction of individuals to a particular risk can vary substantially depending on the type of risk that is present (Beck, 1992). For example, Beck (1992) describes how people react differently towards risks posed by natural disasters when compared to those related to 'manufactured' or 'man-made' risks. Additionally, Maye et al. (2008) suggest that 'new' risks are likely to evoke different reactions to risks that may be familiar. For example, they suggest that a wheat farmer may perceive risks associated with 'known' diseases as relatively low when compared to risks related to 'alien' diseases about which they are less knowledgeable. Maye et al. (2008) also argue that it is often difficult to change a person's perception of a risk once a value judgment is made, particularly if the individual is knowledgeable about the subject. It is therefore likely that a farmer will be more easily persuaded about the best ways to avert the risk of a 'new' disease of which they have little or no knowledge.

There are a number of factors which influence perceptions of, and responses to, risk. According to Botterill and Mazur (2004), these include the characteristics of the individual facing the risk, the characteristics of the risk itself, as well as the social and environmental context in which the risk is placed. For example, beliefs, knowledge and values have been shown to have an important impact on the ways in which farmers perceive the risks posed by climate change. Additionally, the importance of knowledge was also highlighted in a study of Australian farmers which found that a range of situational factors as well as knowledge, beliefs and attitudes influence perceived risk and consequently impact upon levels of innovation adoption (Wyatt and Henwood, 2006). Risk perception and response is clearly influenced by a wide variety of factors, many of which are likely to be socially situated. This discussion therefore now turns to the social context of farmers' risk behavior.

Positive response to a particular risk is likely to involve a certain type of behaviour and understanding the factors that influence farmers' behaviour is essential. In reality decisions are rarely made with full knowledge of all costs, benefits or risks. Behaviour and decision making is often influenced by group dynamics and social norms especially when decisions relate to commonly owned resources or community interests such as in the case of climate change, water abstraction or disease prevention, when individuals are unlikely to act unless others do so as well (Pike, 2008). The benefits of local, horizontal social networks in addressing risk and building resilience have been noted in the literature. Such networks take account of local contexts, knowledge and resources (Ilbery et al 2005, Adger et al 2005, Bernier and Meinzen-Dick 2014).

The geographical nature of social networks is also noted by Bryant and Johnston's (1992) farmer decision-making model which recognises a range of factors that can influence farmer adaptations, many of which are spatially focussed: attributes of the farm operation, such as existence of an heir or the skill set of the farm operator; attributes of the local community, including the availability of farmland or community concerns about particular farm practices; and off-farm factors, such as commodity market prices. The model goes on to identify three types of farmer adaptations: positive adaptations, such as adding non-traditional enterprises or intensifying production on the existing land base; normal or managerial adjustments characteristic of the entire agricultural sector, such as the adoption of a standard agricultural technology (e.g. hybrid seeds); and negative adaptations, such as exit from farming or a

reduction in production intensity in anticipation of the future sale of farmland to developers. Further emphasising the spatial elements of social networks, Sharp and Smith (2003) argue that the adaptations missing from this model are those which are influenced by the local social setting. This type of adaptation involves a farmer building trust and understanding about potential offensive farm practices with neighbours in order to prevent future misunderstanding or conflict. Sharp and Smith (2003) draw on the social capital literature to justify their claim that ‘neighbouring’ should be considered a valid adaptive strategy. They conclude, in agreement with many social capital researchers, that “*people who know and trust one another are more likely to be able to work together to find a solution to problems that are mutually acceptable to everyone.*” They suggest that social capital among farmers and non-farmers is likely to provide several benefits for both the farmer and the wider community, including benefits relating to increased resilience. When faced with risk, farmers have a number of options in terms of their response and it is at this point that the various mechanisms influencing farmer behaviour are important.

Throughout the literature the importance of the wider social context has emerged as being central to our understanding of why individuals respond to risk in the way that they do. Knowledge, beliefs and values have been shown to be key, as have social interactions and networks. While the importance of the social context has been emphasised by social scientists exploring farmers’ attitudes towards bTB and its control (Enticott and Vanclay, 2011; Enticott and Franklin, 2009), no quantitative exploration of farmers’ social networks in relation to their response to bTB has been undertaken. This paper therefore draws on understandings of farmer behaviour, which is explored further in the following section, in order to provide representative data to address this important gap in the literature.

Interpreting farmer behaviour is key to understanding risk perception and the reasons why farmers choose to respond to risk in certain ways. In order to further understand farmer behaviour countless ‘theories of behaviour’ have been developed within the academic literature. Many of these fall within the Theory of Reasoned Action and the Theory of Planned Behaviours, which discuss the main internal and external influences on behaviour. Although the behaviour of farmers is likely to have a substantial impact on the spread of bTB, there has been very little research which addresses it. A small number of exceptions exist, such as a study carried out by the University of Liverpool (2009) which explored changes in farmer behaviour as a result of the introduction of pre-movement bTB testing. Using the Theory of Planned Behaviour, the researchers examined three sets of beliefs:

behaviour beliefs (about the outcome of certain actions); normative beliefs (about what others may or may not approve of); and control beliefs (about the factors that may facilitate a certain behaviour). Moral obligations and habits were also included in the model. The study identified a number of beliefs which influence the behaviour of farmers, including their beliefs about how disease is spread. Additionally, views about the government were also seen as important. Many of the farmers lacked trust and confidence in the information provided by the Department for the Environment, Food and Rural Affairs (Defra) and often felt that the department was too distant and difficult to contact. One of the key conclusions of the study, which is of particular relevance to this paper, is that farmers' decisions are socially situated, dependent on the views of their family, friends and vets. The researchers therefore suggest that in order to influence behaviour, policy makers must focus on farmers' wider networks, concluding that gaining the support of farmers' closest informants is the most appropriate way of influencing their behaviour.

The social context of farmer attitudes and behaviour is also noted by Pike (2008) who argues that in order to fully understand farmers' decisions relating to their practice, it is necessary to explore their underlying attitudes, motivations and objectives. Building on work by Garforth and Rehman (2005), Pike (2008) developed a conceptual framework for exploring farmers' attitudes. Within the framework, he suggests that the intention to undertake a particular behaviour is influenced by attitudes, past behaviours, perception of the behaviour and social factors such as the views of others. Pike's model (shown in Figure 1) builds on the traditional theory of behaviour which identifies attitudes, social factors, past behaviour (internal factors) and external factors (including cost and policy interventions) as being the basic components of behaviour. By incorporating a policy dimension in the form of the sustainable development diamond (the 4 Es) shown in the top right of the model, Pike's (2008) model makes an important contribution to the development of behavioural theory as it emphasises the role of the wider political context and the potential influence of government intervention on individual behaviour. *Insert figure one here*

This diversity has also been noted by policy makers who have begun to develop models of farmer segmentation, recognising that farmer decision making and behaviour is influenced by a wide range of factors, not simply those associated with economic or political contexts. Instead, various social dimensions are increasingly being shown to play an essential role (see for example Collier et al. 2010; Pike 2008). This study builds on previous work by providing

a quantitative assessment of the role of the wider social context on farmers' bTB disease behaviour using the methodology described in the following section.

3. Methodology

The research on which this paper is based formed part of a larger, mixed methods project which incorporated an earlier qualitative phase which helped to inform the development of a quantitative survey. The methodology and findings for the earlier phase are reported elsewhere (reference omitted to maintain anonymity). Data were collected by a postal survey of farmers in the South West of England. The survey was designed to explore farmers' attitudes towards bTB risk and its control with a particular focus on the nature of farmers' social networks. The analysis drew on methods associated with segmentation analysis which has been widely used in recent years within the agricultural context (see for example Pike 2008). Following tried and tested approaches (Urquhart 2009, Tsourgiannis Unpublished Results and Pike 2008), a series of statements were included in the survey, all of which required a 5-point Likert scale response. This approach ensured consistency in the data, which is important for factor and cluster analysis, both of which were used to provide an in-depth exploration of the data.

The South West of England was the area chosen for this study due to the high levels of bTB incidence in the region (Fisher et al., 2012). A random sample of 1500 cattle farmers in the South West was drawn from existing databases. A response rate of 26.7% was achieved, amounting to 401 completed surveys received between November 2011 and the end of January 2012. Of these, 27 had more than 10% missing data and were excluded from the sample, resulting in 374 usable returns (usable response rate = 24.9%).

In order to assess the representativeness of the sample, the data were examined for non-response bias. The characteristics of the sample were compared to data from the Farm Business Survey, conducted on behalf of Defra, in addition to a number of regional reports published by Defra. County level data were compared for a range of variables including farm and herd size, herd type, tenure and farmer age. Similar distributions were encountered in the sample as in the wider population. While there were small differences for some of the variables, the degree of non-response bias was not deemed substantial enough to warrant weighting of the data (Peck et al, 2010). Self-selection bias was also considered. However, due to the large sample size, high response rate and consistency with other data sources, the

data reported in this paper is deemed to be representative of the wider cattle farmer population in the South West of England.

Following descriptive analysis of the data, a two stage approach was adopted. The data were first subjected to factor analysis to reduce the number of variables to those that provided the best explanation of the attitudes and behaviour of the respondents. This was followed by cluster analysis which used the factor scores to cluster the respondents into groups. The software IBM SPSS Statistics 19 was used for the analysis. The findings from this analysis are reported in the following section.

4. Findings

Before presenting the results of the multivariate analysis, it is informative to first provide a summary of the survey sample. A breakdown of the sample by county and herd type is provided in Table 1.

Insert table 1 here

While all of the respondents were cattle farmers, some were from mixed farms with other livestock such as sheep (27.6%) or arable (17.1%). Farms ranged in size from 6.5 hectares to 2000 hectares (median=143.2, standard deviation=158.630). The majority (79.4%) of farms in the sample were less than 200 hectares and only 8 of the farms were over 500 hectares. Within the sample, mixed farms (arable and livestock) were significantly larger than those with only livestock. The average size of mixed farms was 223 hectares. Beef farms were the smallest, with an average of 85 hectares compared to dairy farms which averaged 125 hectares. The largest farms were found in Wiltshire where farms were significantly larger than in other areas. Farms in Wiltshire averaged 213.7 hectares, while the smallest were in Cornwall, averaging 105 hectares.

Over three quarters of the sample had experienced a confirmed bTB breakdown. This is not surprising as national figures show that over half of all TB breakdowns in the UK occur in the South West, with over one quarter of all herds in the region likely to experience a breakdown in any one year (Butler et al., 2010). Of the farmers who had experienced a breakdown, 37% were under restriction at the time of the survey and an additional 44% had experienced a breakdown in the last three years. While some farmers had only lost one or two cattle to bTB, others had lost far greater numbers - up to 500 in one case - with an average loss of 27 cattle in the past ten years. Following the descriptive analysis, multivariate analysis

was undertaken, incorporating factor and cluster analysis as described in the following sections.

4.1 Factor Analysis – identification of underlying strategic variables

As part of the postal survey, a series of statements measured against a 5-point Likert scale were included to explore various aspects of farmers' social networks, trust and attitudes towards bTB. These were subjected to factor analysis in order to reduce the original set of variables into a smaller number of factors, with the aim of explaining correlations between the variables and in turn identifying the underlying dimensions across the set. Principal Component Analysis (PCA) was used for the factor extraction in order to identify the varying attitudes and practices of different farmers. The data were checked for multivariate outliers using the Mahalanobis D^2 measure and cases were removed if responses to any of the statements to be used for the factor analysis were missing. This left 341 cases for the factor analysis. The final factor solution was based on 18 variables and presented 5 factors explaining 60.7% of the variance. The factor solution for this study was rotated using the Varimax method and the factor scores were saved as new variables and later used for the cluster analysis. The factors were interpreted as shown to Table 2, which provides a summary of the variables that loaded heavily on each factor. The label assigned to each factor was based on the variables that it represents. For example, the first factor includes four variables, each relating to the negative impacts associated with bTB.

Insert Table 2 here

4.2 Cluster analysis

The primary purpose of cluster analysis is to group respondents based on their underlying characteristics. Clusters therefore represent groups of respondents who are very similar to each other according to specified criteria. The cluster analysis thus builds on the findings of the factor analysis and allows further interpretation of the data. In short, factor analysis groups variables, while cluster analysis groups respondents.

Firstly, a hierarchical clustering method was used to identify the optimal number of cluster solutions and to identify the starting point (or seed point) for each cluster. A non-hierarchical method was then employed to produce the final cluster solution. The process resulted in two clusters, which were named according to the farmer types that they appear to represent. This was achieved by examining the mean factor scores for each cluster. High mean scores indicate that a given factor is particularly important (if the mean score is a positive number)

or particularly unimportant (if the mean score is a negative number) to the farmers in that cluster. The cluster profiles are shown in Figure 2, followed by a descriptive summary of the farmer types that form the two groups.

Insert Figure 2 here

Cluster 1 - Resilient and externally focused farmers: The first cluster accounts for 52.7% of the sample (n=176). Farmers in cluster 1 are less likely to be concerned about the negative implications of bTB, including the practical, financial and emotional impacts. They are less concerned with having strong bonds with other local farmers, and are also less likely to seek and follow the advice of other farmers. Instead, they are more focused on external influences such as the National Farmers Union (NFU), Defra and their private vet. Farmers in this group believe that the government listens to farmers, which indicates a level of empowerment. They also feel that the government and the NFU are doing a good job in relation to bTB.

Cluster 2 - Vulnerable and internally focused farmers: Cluster 2 farmers are more concerned with the practical, financial and emotional impacts of bTB. They have strong bonds with, and trust in other farmers, but have far less positive relationships with authority. They are less likely to feel a sense of empowerment or to consider the NFU or the government to be doing a good job in relation to bTB. They rarely seek and follow advice from external sources such as the NFU, but instead seek and follow the advice of other farmers. This cluster accounts for 47.3% of the sample (n=158).

4.2.1 Cluster profiling

The two clusters that emerged from the factor and cluster analyses were profiled further by examining a variety of variables to identify any differences between the clusters. Chi-square tests of independence were used for nominal variables and a one way Analysis of Variance (ANOVA) was conducted on the remaining variables¹. This allowed information from the survey, which had not been used in the factor or cluster analyses, to further characterise the clusters. The data used for this consisted of descriptive variables, such as farm and farmer characteristics, as well as farmer attitudes, management activities, sources of information, and levels of trust. The main aim of this was to establish the statistical differences between

¹ Examinations of skewness and kurtosis values confirmed that normality assumptions were valid.

the farmers in the two clusters. Significant differences between the cluster groups were found for a number of the variables, supporting the external validity of the clusters.

There were no significant differences between the groups in terms of farm type or size, tenure or the proportion of income derived from their cattle. However, a number of statistically significant differences between the two farmer groups were found on a number of variables relating to risk perception and farmers' social networks. Farmers in the *vulnerable and internally focused* group are more fatalistic towards bTB. A higher number felt that it was likely that their herd would fail their next bTB test compared to those in the *resilient and externally focused* group ($F=11.230, p=.001$). They were also more likely to feel that there is nothing that farmers can do to reduce the risk of their herd going down with bTB ($F=4.542, p=.034$). Respondents were asked about their confidence in the skin test used on cattle to establish whether or not they have bTB. Farmers in the *resilient and externally focused* group have a higher level of confidence in the skin test compared to those in the *vulnerable and internally focused* group ($F=18.944, p<.001$).

Farmers were asked a series of questions about their uptake of recommended on-farm biosecurity measures. Supporting previous research (Enticott, 2008b; Gunn et al., 2008; Bennett and Cooke, 2005), uptake was fairly low across the sample and no difference in the level of uptake was found between the two groups. This suggests that across the sample farmers lacked confidence in the effectiveness of on-farm biosecurity measures to reduce the risk of their herd testing positive for bTB, further reiterating the uncontrollable nature of the disease.

In order to understand more fully the role of social factors in influencing the attitudes and behaviour of farmers in relation to bTB, a number of questions aimed at exploring farmers' support and knowledge networks were included in the survey. Both internal (within the farming community) and external (outside the farming community) networks were investigated and some statistically significant differences were found between the two groups. As expected, farmers in the *vulnerable and internally focused* group were more likely to have an internally focused support network, made up mainly of family and other farmers. For example, a higher number of farmers in this group had done a favour for another farmer than those in the *resilient and externally focused* group ($F=7.198, p=.008$). Farmers in the vulnerable group were also less likely to feel excluded by other farmers ($F=6.184, p=.013$). *Resilient and externally focused* farmers were more likely to feel that there is plenty of

support available to farmers who are worried about bTB compared to those in the *vulnerable and internally focused* group ($F=16.801$, $p<.001$). However, there was no statistically significant difference between the groups in terms of whether the respondents felt that there are sufficient numbers of people that they can talk to if they are stressed or upset ($F=.403$, $p=.526$). Thus there appears to be a distinction between support available to farmers from external sources and the emotional support that they may access within their close, internal networks. In turn this suggests that although farmers in the resilient group are more externally focused, they do not appear to lack emotional support.

Respondents were asked about their wider support networks and their attitudes towards the government and bodies such as the NFU. A highly significant difference was found between the groups in terms of NFU membership ($F=23.002$, $p<.001$) and a substantially higher proportion of resilient farmers were NFU members. Resilient farmers were also more likely to have attended an NFU meeting in the past three years ($F=9.163$, $p=.003$). Farmers in the *vulnerable and internally focused* group were also found to have less contact with the NFU than *resilient and externally focused* farmers ($F=13.840$, $p<.001$).

Resilient and externally focused farmers were more able to cope with the impacts of bTB and were less likely to express concern about the financial, practical or emotional impacts associated with the disease ($F=108.789$, $p=.001$). The farmers in this group also have more positive attitudes toward authority, including the government and the NFU. They believe the government to be interested in what farmers think about bTB and feel that, by working together, farmers can influence decisions ($F=246.793$, $p= <.001$). *Resilient and externally focused* farmers seek information and advice from contacts outside of their immediate farming network such as their vet, the NFU or Defra ($F=10.267$, $p<.001$).

In comparison, farmers in the *vulnerable and internally focused* group are far more concerned about the impacts of bTB, noting the stress, upset, and the financial and practical implications associated with a bTB breakdown ($F=108.789$, $p=.001$). Farmers in this group also demonstrate negative attitudes towards authority ($F=246.793$, $p= <.001$). Additionally, these farmers are more likely to seek advice and information from other farmers rather than external contacts ($F=1.636$, $p<.001$). These results raise some interesting questions about the various social factors that influence a farmer's response to bTB, which are discussed in the following section.

5. Discussion

The two farmer groups that were identified in the previous section reflect the diversity in attitudes and responses towards bTB and its impacts. The analysis aimed specifically to explore the role of social networks in influencing farmers' risk perception and behavior. The farmers in the two groups differ significantly both in terms of the attitudes towards bTB and its control and well as in relation to the social networks in which they are situated. *Resilient and externally focused* farmers are more likely to draw on external networks outside of the immediate farming community and have been shown to be better able to cope with the impacts of bTB. In comparison *vulnerable and internally focused* farmers are more likely to draw practical and emotional support from other farmers rather than external contacts and are more fatalistic towards the disease and are more concerned about the negative impacts of bTB. It is important to note, however, that those farmers categorised as *resilient and externally focused* were not entirely reliant on external contacts or completely unconcerned with the negative impacts of bTB. Instead, the analysis shows that farmers in this group were less likely to focus heavily on relationships with other farmers but were instead more inclined to seek advice and support outside of the farming community. Similarly, farmers in this group were less concerned with the negative impacts of bTB when compared with farmers in the vulnerable and internally focused groups. In support of other work which identifies different farmer groups (see for example Collier et al., 2010), the boundaries between the two groups are likely to be 'fuzzy', with some farmers positioned on the 'edge' of a particular group. Such farmers, although having many of characteristics which define the group may also share some of the characteristics of the other group. This represents a form of vulnerability/resilience scale whereby farmers positioned on the edge of the *vulnerable and internally focused* group nearest the *resilient and externally focused* group are more resilient than farmers who are positioned at the center of that group. Further analysis would be useful to explore the characteristics of the positioned at the 'edge' of the groups, although this is outside the scope of the current paper. While the 'fuzzyness' between the farmer groups represents a potential limitation of this research approach, the analysis has nonetheless provided a useful vehicle through which to explore the various issues raised by this paper.

While the findings have identified an important relationship between farmers' bTB response capacity and the nature of a farmer's social network, it has been shown that while having a broader network incorporating a diversity of contacts can have a positive influence on farmers' ability to cope with the impacts of bTB, in terms of dealing with the potential

financial, practical or emotional impacts associated with a disease breakdown, it does not necessarily influence their ability to avoid the disease through positive action. There is an important distinction to be made here between the role of social networks in influencing farmers' attitudes as opposed to behaviour. The complexities associated with understanding an individual's response to a particular risk have been noted in the literature, with numerous continua or models of resilience being suggested. Pelling (2010) distinguishes between "resilience (maintaining the status quo), transition (increasing mental change) and transformation (radical change)". While this study has identified that some farmers are better able to cope with the disease, such farmers are characterised by their attitudes rather than their actions. According to Pelling's (2010) conceptualisation, farmers who are more able to cope with the impacts of bTB could therefore be considered to be resilient, and in some circumstances in transition, but they have not progressed to the transformation stage. For example, no differences between the farmer groups were found in relation to the uptake of biosecurity measures or levels of active empowerment (e.g. contacting their local MP, attending protests etc.) which represent transformative activities. Instead, more resilient farmers held more positive attitudes towards the government, were less fatalistic about the disease and had higher levels of perceived empowerment (e.g. felt that they could work with other farmers to influence policy if they wanted to, but did not report actually doing so).

While the role of social networks in changing attitudes is often noted, it is generally discussed within the context of changing behaviour. For example, while Oerlemans and Assouline (2004) found that certain social ties had a strong influence on farmers' attitudes towards change, such attitudes were translated into positive behavior in relation to sustainable agricultural practices. However, based on the findings reported in this paper, there appears to be a disconnection between farmers' attitudes and their behaviour. Farmers who are less fatalistic towards bTB or have more positive attitudes towards the government do not necessarily exhibit any different behaviour to other farmers. While more positive attitudes have been shown to help farmers cope, they have not been shown to increase the implementation of avoidance or adaptation strategies that could reduce the risk of their herds contracting bTB.

In order to understand more thoroughly the complexities associated with the relationship between attitudes and behaviour, it is useful to revisit Pike's (2008) farmer behaviour model presented earlier in the paper (Figure 1). Pike (2008) argues that while the intention to adopt

a particular behaviour is a function of attitudes, other social factors such as the views of others and past behaviour are also important, as well as the extent to which the behaviour is believed to be possible. This study has shown that relationships with individuals and groups outside of the immediate farming community can positively influence attitudes and intentions. They can lead to feelings of empowerment and reduce anxiety. However, in comparison, strong internal ties can lead to fatalistic tendencies and norms of behaviour which can act as barriers to attitudinal change. Nonetheless, while a wider social network has been shown to lead to changes in intention, there still remain barriers to changes in behaviour. Pike (2008) suggests that intention to act is facilitated by external measures and incentives (such as those put in place by the government). In order to address these barriers, Pike's model puts forward a number of external interventions which are shown in the top right of the model (engagement, encouragement, enabling and exemplifying). Farmer engagement, as well as leading by example (exemplifying), are shown to influence the internal factors such as social norms and the views of others. Interventions that encourage and enable them (such as the provision of financial incentives) are shown to remove potential barriers to behavioural change. The benefits resulting from a particular behaviour are also shown to influence future behaviour.

This model is informative in understanding the potential constraints or barriers which prevent positive behaviour change and in turn how various policy measures may be implemented to address them. The findings presented in this paper suggest that interventions to influence internal factors may first be required to influence the attitudes of those farmers currently classed as *vulnerable and internally focussed*, while interventions to remove behavioural barriers are required to encourage those classed as *resilient and externally focussed* to undertake particular behaviour. The 'four E's' put forward by Pike are discussed in more detail below in the context of the study findings.

This study has shown that *engagement* with individual farmers and with contacts within their network is essential in order to develop trusting and productive relationships as well as enhancing feelings of empowerment. One of the most significant differences between the resilient and vulnerable farmers was levels of NFU membership, with membership among resilient farmers being substantially higher. Farmers in this group were more likely to attend NFU meetings regularly and have contact with NFU representatives. The findings of the study show that NFU membership and involvement in the organisation is likely to increase feelings of empowerment and access to knowledge. This suggests that farmers involved in the

NFU are more likely to feel that the government is interested in their views. While such relationships do not necessarily provide access to a wide range of resources, such as physical or financial capital, they do help to change farmers' attitudes, providing a move away from the fatalistic norms and collective negativity that may be present among certain farmers. Due to the lower levels of NFU membership among farmers in the vulnerable and internally focused group, there is an indication that such farmers may feel they have no outlet through which to voice their views about bTB. The findings suggest that farmer engagement is essential for changing attitudes and therefore potentially changing behaviour. In order to increase levels of farmer engagement, additional opportunities for farmers to voice their views should be provided, particularly those who are not members of the NFU.

To address the fatalistic norms which have developed among the *vulnerable and internally focused* farmers, interventions which *exemplify* more positive behavioural norms would be beneficial. Research has shown that strongly engrained beliefs and norms of behaviour are present among many farmers, which potentially limit the uptake of proactive disease response strategies (Fisher, 2013). Within this study, many of the farmers categorised as *vulnerable and internally focused* have been shown to share collective feelings of fatalism leading to norms of behaviour that may contravene government recommendations. While influencing norms or creating new norms is not simple, new norms have been shown to emerge over time. For example, within the past twenty to thirty years there has been a clear shift within the farming industry from strongly engrained post-war productionism to a more conservationist and environmentally focused farming culture (Dallimer et al, 2009). This shift has been achieved through a range of incentives (e.g. agri-environment schemes) and government regulations (e.g. Cross Compliance), but also through encouraging certain farmers to influence their peers through the use of demonstration farms and farmer role models (Morris and Potter, 1995). Such approaches may also be beneficial in influencing farmers' responses to bTB.

For *resilient and externally focussed* farmers, it is necessary to remove any barriers which may prevent the uptake of a particular behaviour. Certain measures could be used to *enable* farmers, for example the provision of financial incentives. Study participants were asked about this and many suggested that they would be more likely to implement biosecurity measures if they were grant aided. Although the current bTB compensation system is generally successful in buying farmers' cooperation with the government's test and slaughter policy, Enticott and Law (2012) argue that the current policy of paying farmers compensation

for animals lost due to bTB does not provide a strong incentive for the implementation of biosecurity. Therefore, it may well be worth considering linking compensation payments with the implementation of biosecurity or indeed providing grants to enable farmers to invest in biosecurity measures.

In terms of *encouragement*, building trust in the government will make farmers more likely to follow the advice provided to them. The results of this study suggest that regular and consistent contact is important. However, the findings also indicate that at present farmers often find it difficult to contact the same government representative more than once. Other studies have shown that farmers view their private vets as important informants and trust the advice that they provide (Fisher, 2013; Enticott and Vanclay, 2011). Using vets as mediators between farmers and the government may therefore help to encourage farmers to adopt particular behaviours.

6. Conclusion

Currently, bTB remains a substantial risk for farmers in England as well as in many other countries across the world (Fisher, 2012; Schmitt et al, 2002). The path to disease control and eradication is long; however moves are currently being made within the UK by the government to take action to tackle the disease both in cattle and in wildlife (Defra, 2013b). This study has shown that major disparities exist between the current disease control strategy, which emphasises disease avoidance, shared responsibility and cooperation, and the lack of action currently being taken by farmers to respond to the disease.

While some farmers have been shown to be better able to cope with the impacts of bTB, in general, few appear to be taking any clear action to reduce the risks associated with the disease or prevent their herds contracting it all together. While coping is an important response, it does not have a positive impact on the eradication of the disease at a national level. Based on the findings presented in this paper, there appear to be a number of barriers which prevent some farmers from coping with the impacts of the disease and others from taking transformative action to reduce their disease risk. Specifically, this study explored the role of social networks and found that farmers who are most vulnerable are those who are internally focussed and rely on contacts within their own family or farming networks. This appears to encourage the development of fatalistic norms and feelings of disempowerment.

Conversely, those farmers who have wider networks and stronger relationships with external contacts including government representative and bodies such as the NFU have more positive attitudes towards disease control, coupled with feelings of empowerment. However, this study has shown that more resilient attitudes do not necessarily translate into positive behaviour. Instead there appears to be a number of barriers to behaviour change which must be addressed. While this is not a simple process, and this paper only addresses a small number of the barriers that may be present, the various interventions outlined are useful to consider.

The disconnect between attitudes and behaviour identified by this paper within the context of bTB has a wider significance to disease control policy more generally, and to the implementation of successful interventions to positively influence farmer behaviour. While this study has focussed specifically on the UK, lessons learned are relevant within the international context in relation to furthering our understanding of the complexities associated with farmer decision making and political intervention. It is necessary to recognise the importance of different types of intervention; those which may impact one farmers' response may not be appropriate for another farmer. It is therefore essential that policy makers appreciate the need for a range of intervention measures, which recognise the diversity within the cattle farming industry, rather than implementing a 'one size fits all' approach. While some farmers may only need interventions which remove external barriers such as financial constraints to encourage a particular behaviour, others require interventions which address internal factors, including social networks, norms and attitudes. Through doing so, progress can be made to enhance cooperative action across the agricultural industry and the government to tackle and eventually eradicate what is currently one of farming's most pressing issues.

Figures and tables

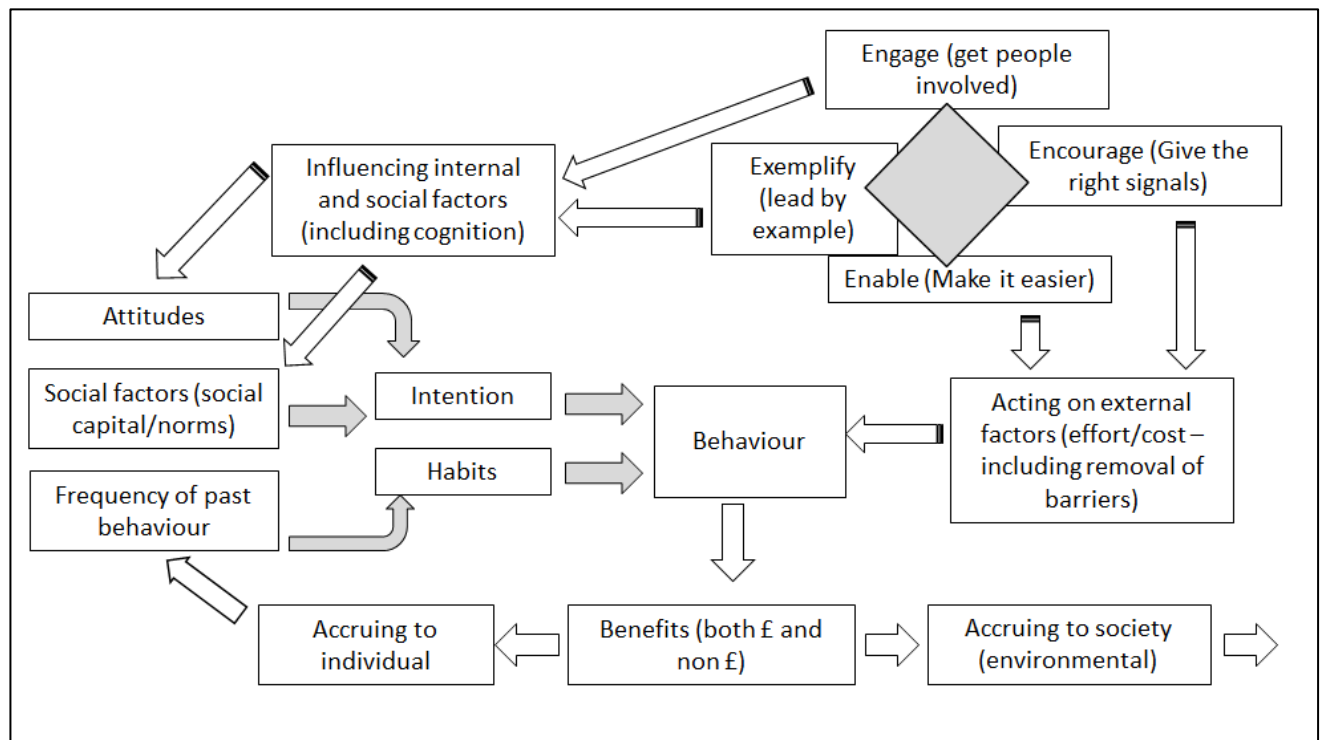


Figure 1: Pike's (2008) Integrated approach to influencing farmer behaviour

County	Beef (%)	Dairy (%)	Beef and dairy (%)	No response (%)	Total (%)
Devon	51.6 (n=64)	31.5 (n=39)	16.9 (n=21)	0	33.2 (n=124)
Somerset	47.8 (n=33)	33.3 (n=23)	18.8 (n=13)	0	18.4 (n=69)
Cornwall	45.0 (n=27)	33.3 (n=20)	20.0 (n=12)	1.7 (n=1)	16.0 (n=60)
Gloucestershire	56.1 (n=23)	26.8 (n=11)	14.6 (n=6)	2.4 (n=1)	11.0 (n=41)
Wiltshire	46.2 (n=18)	28.2 (n=11)	20.5 (n=8)	5.1 (n=2)	10.4 (n=39)
Dorset	35.5 (n=11)	48.8 (n=15)	16.1 (n=5)	0	8.3 (n=31)
Unknown	30.0 (n=3)	50.0 (n=5)	20.0 (n=2)	0	2.7 (n=10)
Total	47.9 (n=179)	33.2 (n=124)	17.9 (n=67)	1.1 (n=4)	n=374

Table 1: Summary of sample by county and herd type

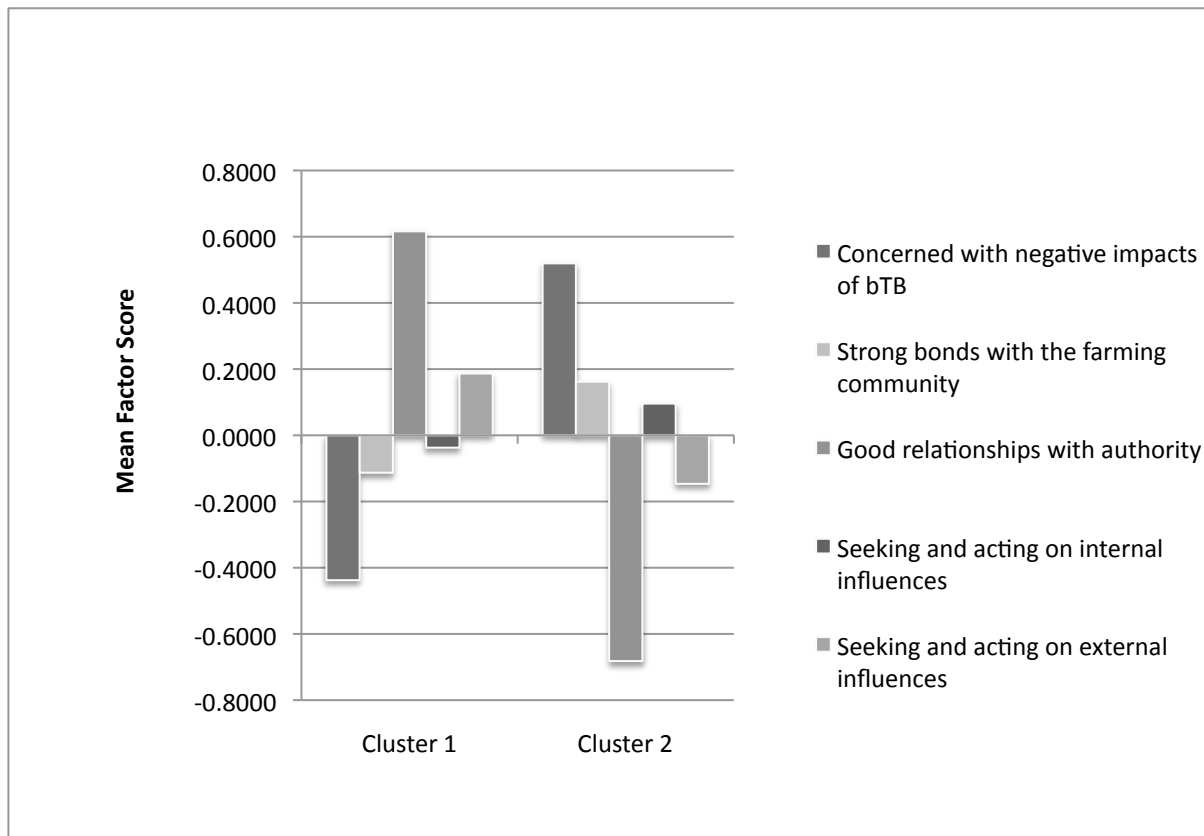
Variable	Factor loading
Concerned with the negative impacts of bTB	
v.18 Going down with bTB is/would be very stressful	0.913
v.19 Going down with bTB is/would be very upsetting	0.882
v.17 Going down with bTB has/would have a major financial impact on my business	0.802
v.16 BTB creates a lot of extra work	0.550
Strong bonds with farming community	
v.7 Most farmers in the local area look out for each other	0.819
v.6 I trust most of the farmers in my local area	0.812
v.12 I do not feel excluded by other farmers	0.671
v.5 I know most of the farmers in my local area	0.619
Good relationships with authority	
v.9 The government is interested in what farmers think about bTB	0.782
v.8 The government is doing a good job in relation to bTB	0.773
v.10 The NFU is doing a good job in relation to bTB	0.677
v.11 By working together farmers can influence decisions that are made relating to bTB	0.581
Seeking and acting on internal influences	
v.14 I often follow the advice of others farmers in relation to bTB	0.760
v.13 I often speak to other farmers about bTB	0.758
Seeking and acting on external influences	

v.29	I follow advice from Defra relating to bTB	0.781
v.31	I follow the vet's advice relating to bTB	0.718
v.30	I follow advice from the NFU relating to bTB	0.672
v.24	I am happy to try new things to reduce the risk of bTB	0.596

Extraction method: Principal Component Analysis; Rotation method: Varimax with Kaiser Normalization

Table 2: Principal Component Analysis of Variables

Figure 2: Final Cluster Profiles



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