The Ecological Paradox:
Social and Natural Consequences of the Geographies of Animal Health Promotion

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Abstract

Drawing on the example of bovine Tuberculosis (bTb), this paper examines the geographies of animal health promotion. Using theories from the sociology of health, the paper outlines how the spatial practices of animal health promotion have had adverse policy consequences – what the paper refers to as an 'ecological paradox'. Analysis of ethnographic interviews with 61 farmers in England and Wales provides a range of reasons why farmers do and do not implement biosecurity. Drawing on the concept of lay epidemiology and ideas of 'the candidate' – that is, the terms by which someone/thing is most likely to suffer from a particular illness – the paper shows how farmers construct farmers, cattle and badgers as likely to be a candidate for bTb; and how aspects of luck and fatalism are significant elements of candidature. These effects are traced to a clash of spatial practice within the different knowledge articulated by official attempts to promote animal health and farmers' understandings. In failing to consider these cultural understanding of disease, the paper argues that the state's attempts to promote animal health have served to reinforce the explanatory power of candidacy and traditional understandings of bTb, thereby overriding attempts to promote biosecurity. The resulting negative consequences for badgers, cattle and farmers are defined as the ecological paradox.

Key Words:

Biosecurity; Animal Health; Health Promotion; England and Wales; Farmer Interviews

Introduction

According to the Department for Environment Food and Rural Affairs (Defra, 2005a), bovine tuberculosis (bTb) is one of the most difficult animal health problems currently facing the UK. Present in cattle and badgers, and transferable to humans, attempting to control its spread currently costs the UK taxpayer £90million per annum. These attempts focus attention on circumventing relations between a range of natural agents: the bacteria *Mycobacterium bovis*, wildlife and cattle. However, the problem of bTb and animal health in general is also a social and geographical question. Resolving animal health problems has always been a matter of geography. Traditionally, this has involved attempts to contain the 'flow' and 'mobility' of animal disease from place to place within the globally connected network of sites of agricultural production (Law, 2006). Preventing the pollution of these commodity flows from animals at infected individual farms to other agricultural spaces demands the creation and definition of new spaces: those which are officially free from disease, and those which are not. Ensuring the smooth flow of untainted agricultural commodities within this geography requires a set of rules, procedures and practices to standardise and purify global agricultural space from the disrupting influence of disease (Donaldson and Wood, 2004; Atkins, 2007; Hinchliffe, 2007). More commonly, these are referred to as 'biosecurity' (see Donaldson, 2008; Bingham and Hinchliffe, 2008; Hinchliffe and Bingham, 2008; Braun, 2007). Patrolling the boundaries of diseased agricultural spaces is therefore a social and cultural concern. It depends, for example, on farmers' motivations to conform to biosecurity regulations;

governments to adequately resource regulatory agencies; and the effective practice of animal health surveillance mechanisms by veterinarians.

Biosecurity regulations specified by the Office Internationale des Épizooties have sought to define and control the spaces of diseased agriculture at a global scale. Increasingly, though, governments have focused on encouraging farmers and the agricultural industry to take 'ownership' of animal disease problems (see Defra, 2005a). In part, this emphasis represents a neoliberal turn in the governance of animal health. Firstly, the economic cost of dealing with animal health crises has directed governments to find ways of relinquishing animal health costs and responsibilities to the agricultural industry. Secondly, the state has adopted a role which seeks to encourage farmers to take 'ownership' of animal problems by voluntarily implementing localised forms of biosecurity as part of their responsibility towards their livestock. Such attempts, though, are underpinned by a further set of social and geographical dimensions. In particular, the approaches adopted by the state to promote biosecurity practices reflect specific 'spatial practices' (Lefebvre, 1991) inherent within different styles of knowledge advocated by different social groups (Bickerstaff and Simmons, 2004; Enticott, 2001). For example, drawing on Thrift's (1996) typology of knowledge practices based on place-specific practical knowledge or abstract knowledge empirically derived and applicable to large tracts of space, Bickerstaff and Simmons (2004) suggest that these respective knowledges can be referred to as 'proximate' and 'distant' because of their inherent spatialities (Bickerstaff and Simmons, 2004). Such geographies potentially have consequences for communicating health risks and motivating behaviour change.

The aim of this paper is to show how the spatial aspects of biosecurity knowledges impact upon the acceptance and uptake of biosecurity advice by government agencies. In particular, it focuses on what I call the ‘ecological paradox’. I derive this term from two sources. First, from the ‘ecological fallacy’ (Robinson, 1950) for its warnings about the relationship between aggregate data and individual behaviour that are all too familiar for geographers (Johnston, 1976; Openshaw, 1984). Here concern has been directed at the misdiagnosis of individual behaviour and its resultant consequences for social policy. The ecological fallacy is an implicit part of the second concept – that of the ‘prevention paradox’ (Rose, 1985, 1992) drawn from the sociology of health. The prevention paradox is the result of a specific approach to health promotion known as the ‘population approach’. It relies on epidemiological data and the communication of health risk factors and ameliorative actions across a large geographical area. In this, the population approach contains a distinct geographical style of knowledge, but falls into the traps set by the ecological fallacy. The resulting paradox is that whilst health promotion initiatives seek to improve health, their ecological fallacies often reinforce behaviours associated with poor health (Davison et al, 1991).

Much has been written about the effectiveness of the population approach and its links to the prevention paradox within public health, but how these concepts might relate to attempts to promote animal health is unclear. Studies of the prevention paradox are focussed on humans – its effects are explored in relation to their health and their bodies. The ecological fallacy, too, focuses largely on social characteristics, human behaviour and its relationship with social policy. By conflating the ecological fallacy with the prevention paradox – the ecological paradox – the aim of this paper is therefore to explore how the consequences of different geographical approaches to animal health promotion are not just social, but distributed across social and natural populations.

The paper begins by outlining the spatial practices within different approaches to health promotion and their potential effects upon public understandings of health. The paper then applies these theories to animal health: firstly, it introduces the problem of bovine tuberculosis; and secondly, drawing on the concept of lay epidemiology and ideas of 'the candidate' (Davison et al, 1991) within the sociology of health it shows how farmers construct understandings of bovine tuberculosis and biosecurity; how these understandings are reinforced by the spatial practice of the population approach; and how this approach may result in behavioural changes not anticipated by policy makers. In conclusion, I suggest practical solutions to these problems and argue for greater use of social science within the management of animal health problems.

The geographies and consequences of health promotion

The sociology of health and illness has paid particular attention to the ways in which health promotion messages are constructed, communicated, understood and acted upon by the general public. Within this, Rose's (1985, 1992) seminal work on health promotion contrasts the experiences of 'sick individuals and sick populations' and their consequences for preventive medicine. Rose argues that a focus on sick individuals leads to a focus on the causes of individual cases, whilst a focus on sick populations is concerned with the causes of incidence. Preventive strategies also differ along the same lines. Rose suggests that a focus on sick individuals requires a ‘high risk strategy’. This approach targets those at higher risk of particular illnesses through, for example, medical screening, so as to provide treatment that is relevant to the individual and only to those in need. This approach is cost-effective, motivational for both patient and physician, but may also find borderline cases for whom appropriate treatment is not available. More seriously, Rose argues that the approach ‘does not deal with the root of the problem, but seeks to protect those who are vulnerable to it’ (Rose, 1985; 36). As a result, by requiring individuals to change their lifestyle contra social norms, it is behaviourally inappropriate. As Rose points out: ‘no-one who has attempted any sort of health education effort in individuals needs to be told that it is difficult for such people to step out of line with their peers’ (Rose, 1985: 37).

For sick populations, an alternative population strategy is required. This seeks to ‘control the determinants of incidence, to lower the mean level of risk factors, to shift the whole distribution of exposure in a favourable direction…in its modern form it is attempting…to alter some of society’s norms of behaviour’ (ibid.). Unlike the high risk approach, it targets whole populations using mass communication in an attempt to make health interventions behaviourally appropriate. However, a significant drawback is what Rose calls the ‘prevention paradox’ – that is ‘a preventive measure which brings much benefit to the population offers little to each participating individual’ (Rose, 1985: 38). Citing epidemiological data, Rose explains that the generalised prescriptions contained within the population strategy offer just ‘a small benefit to each individual, since most of them were going to be alright anyway’ (ibid.). As a result, these strategies are demotivating for both patients and physicians: ‘grateful patients are few in preventive medicine, where success is marked by a non-event’ (ibid.).

The prevention paradox can be viewed as a form of and a behavioural/medical consequence of the ‘ecological fallacy’ (Robinson, 1950): that is, the overuse and communication of abstracted data to large populations is not only inaccurate, but likely to result in adverse policy consequences. A prime example of this is illustrated by Davison et al’s (1989, 1991, 1992; Frankel et al, 1991) work on coronary heart disease. Davison et al’s (1991: 6) research highlights the extent to which medical disciplines such as aetiology have ‘identifiable counterparts in the thoughts and activities of people outside the formal medical community’. One example is that of ‘lay epidemiology’. Davison et al (1991: 7) stress the extent to which this form of lay knowledge has much in common with its scientific equivalent: ‘individual cases (from personal observation or report) of people who are known to have suffered heart disease are purposefully linked to other circumstances surrounding the event. From this data, regularities are noted and these contribute to the generation of explanatory hypotheses which serve to challenge or support suspected aetiological processes’. These ideas are mediated, circulated and amplified within popular culture and by communities of place, interest and practice. The overall effect is to give ‘coherent form and substance by the use of an overall profile or image of the kind of person who tends to suffer from heart trouble. This person is the “candidate”’ (ibid.).

Davison et al (1991: 8) identify four distinct uses of the idea of candidacy. Firstly, candidacy is used as a retrospective explanation; secondly, to predict other peoples' illness and death; thirdly, as a retrospective explanation of one's own illness; and fourthly, as an assessment of one's own risk from illness or death. In each case, candidacy rests on physical appearance, social information and personal information (p.11). Social information relates to hereditary factors, geographical factors and occupational status. Personal information refers to the individual's own behaviour, such as 'smoking, eating large amounts (especially of fatty food), or consuming excessive amounts of alcohol…[or] whose personal natures tend towards nervousness, excessive worry or regular bouts of anger' (p.12).

The concept of the candidate operates as a cultural 'mechanism which orders experience and observation' allowing people to make sense of everyday events and ill health (Davison et al, 1991: 8). It creates mental and social representations of the type of people who are likely to be ill and the behavioural reasons for being so. However, this way of understanding health is also recognised to be fallible: 'not all candidates develop the illness' and/or that 'deaths occur to people who do not fit any particular candidacy profile' (Davison et al, 1991:14, emphasis in original). One such anomaly recognised by Davison et al is the figure of "Uncle Norman" – the person known by many who drank, smoked and ate unhealthily until his death at a ripe old age. By contrast, there are those "health fanatics" who follow all health advice, yet drop dead in their prime. These 'unwarranted survivals' and 'unwanted deaths' are explained through the omnipresence of chance. In this respect, Davison et al argue that the notion of the candidate provides a second function of explaining the role of bad luck, chance and randomness of sudden events, alongside its first function of predicting illness and assessing risk (cf. Pill and Stott, 1982). These anomalies prove to be powerful social imagery in guiding health behaviour, reflecting the importance of both locally and culturally derived experiences of illness. Inherent within these understandings is a 'privilege of experience' (Williams and Popay, 1994) which relates to the importance of common-sense, folk ideas and local identity in the cultural experience of illness, and which provide a 'transformative effect' (Hunt and Emslie, 2001: 445) in understanding health risks and determining health-related behaviour (Enticott, 2003).

The prevention paradox is an inherent part of the candidate system – the motivation to change behaviour will be questioned because the provision of general advice leads to 'a situation in which many individuals change their lives to no personal end – they would not have had a heart attack anyway' (Davison et al, 1991: 15). But Davison et al argue that the simple health promotion messages responsible for this paradox have two further consequences: firstly, because so many other factors are involved in illness causation, the number of individuals who survive risky behaviours becomes greater. This happens because aspects of lifestyle previously considered 'normal and safe' become labelled as pathogenic. Secondly, while the number of coronary cases who were not apparently at risk diminishes, 'the cases of the individuals who do all the 'correct' healthy things and yet still succumb to heart trouble become very well known' (Davison et al, 1992: 683). These 'unwanted deaths' are part and parcel of the candidate system. However, the ironic consequence of the population approach to health promotion is therefore ‘that these cultural concepts are given more rather than less explanatory power by the activities of modern health educators, whose stated goals lie in the opposite direction’ (Davison et al, 1991: 16).

By now, it should be clear that the strategies and effects of health promotion are inherently geographical. They are based on knowledge collected in different ways which leads to the practice of health promotion occurring in and communicated from/to different geographical sites. The high-risk strategy involves a more localised and situated form of knowledge exchange between doctor and patient within a specified site of interaction (e.g. hospital) which may allow for a more contingent and ‘proximate’ reasoning of appropriate ameliorative actions (Berg, 1997). The geography of the population approach though is quite different: it remains a ‘distant’ technology, transmitted from afar and based on geographically general rather than specific reasoning, over-riding the local and cultural experience of illness. This appears to be the cause of its problems identified by Davison et al: its focus on standardised risk factors disconnects individuals from their social context (Popay et al, 1998) thereby highlighting the gap between personal experience and scientific explanations of the same reality (Gifford, 1986). The significance of lay epidemiology and the candidate system therefore presents a challenge to the population approach’s use of simple health messages. It provides a framework in which risks are amplified and transformed through their communication at local and national scales (Kasperson et al, 1988). The challenge facing health promoters is finding ways of dealing with its impact by paying attention to the translation of the cultural and geographical assumptions within their strategies.

The problem of bovine tuberculosis and the rise of biosecurity as a population approach to animal health promotion

How might this relate to animal health? To answer that, I now turn to the problem of bovine Tuberculosis. Since the late nineteenth Century, bTb has been recognised as a serious disease affecting both cattle and human health.. For the purposes of this paper, the story starts in 1971 following successful policies of milk pasteurisation and meat inspection that had led to the near eradication of the disease (MAFF, 1965. Detailed historical accounts of bTb are provided in: Dormandy, 1999; Waddington, 2006). The early 1970s witnessed a key event that reignited and reframed the problem of bovine tuberculosis. By chance, a bTb infected badger was discovered on a Gloucestershire farm in 1971 that had recently suffered from a bTb breakdown. The Ministry of Agriculture, Fisheries and Food (MAFF) responded to these events with a range of badger culling policies after trials had shown a strong statistical association between culling badgers and disease levels. However, by the mid 1990s there was concern that these policies were not working. In 1996 a scientific policy review was commissioned to propose solutions based on "sound science" (Krebs, 1997). The resulting report established a series of scientific badger culling trials to establish its effectiveness in controlling bTb. The Independent Scientific Group (ISG) chaired by John Bourne was established to run the culling trials between 1998 – 2005 but its final conclusions suggested that ‘badger culling can make no meaningful contribution to cattle TB control in Britain’ (ISG, 2007: 5). Although the ISG recognised badgers to play a significant role in transmitting bTb to cattle, their conclusion was based on the significance of badger ‘perturbation’ following culling events. That is, the ISG argued that incomplete badger culling disrupts badgers social groups and territories, resulting in the remaining badgers migrating and spreading bTb because of increased contact with infected badgers (Woodroffe et al, 2006). Instead, the ISG recommended tighter controls on cattle movements, greater use of better diagnostic tools and enhanced on-farm biosecurity (ISG, 2007). Defra also instigated a system of pre-movement testing to confirm cattle were bTb-free before they could be moved (e.g. to market). Agricultural interests nevertheless continued to call for badger culling as a means of eradicating the disease (EFRA, 2006).

Calls for more on-farm biosecurity represented a new approach. Traditionally, cattle were tested for bTb using an intradermal tuberculin injection (known as the ‘skin test’). Cattle that reacted to the test were slaughtered and cattle movement restrictions imposed upon the whole farm until subsequent tests proved the absence of bTb within the herd. However, as research revealed the limited contribution that badger culling made to the disease, greater calls were made for ‘enhanced on farm cattle and wildlife biosecurity’ (ISG, 2006: 6). Firstly, this view was supported by research that revealed that badgers infected with TB were likely to forage for food in cow sheds at night, urinating and defecating upon silage and other food sources (Garnett et al, 2002, 2003). Farmers were exhorted to do more to prevent badgers from entering their cattle sheds and feed stores and to fence off pasture from badgers by government ministers who claimed that some farms had 'absolutely no bio-security whatsoever' (EFRA, 2004: 13). Support for these arguments came from politicians within the government's agricultural select committees (SCA, 1999; EFRA, 2004), scientists and badger protection groups. Thus, by 2004, improved biosecurity and husbandry were therefore seen as key weapons in the fight against bTb by scientists, politicians and conservation groups (for a more detailed account see Enticott, 2008).

Some of this biosecurity advice was already in the public domain but was overshadowed by the debate over badger culling. In responding to these new calls, Defra sought to promote the role of biosecurity by relying on a population strategy. Government sponsored biosecurity advice identified general risk factors and communicated them to farmers through various media. For bTb, this occurred through a series of leaflets aimed at farmers. Firstly, the 'TB in your herd: reducing the risk' booklet was produced by the Ministry of Agriculture Fisheries and Food in 1999. This focused on two risks that farmers could deal with: minimising cattle to cattle spread; and minimising wildlife contacts. In 2006, this advice was updated following new research which suggested that the previous advice was in fact wrong. New guidance leaflets focussed on three main risks: keeping badgers away from stored cattle feed; making farmyards less attractive to badgers; and grazing on high risk areas of pasture (e.g. badger latrines) (Defra 2007a,b).

General biosecurity messages were also communicated to farmers through other leaflets. These invariably focussed on the role of cleanliness and disinfectant as a means of reducing risk and the statutory cleansing requirements for vehicles at animal gatherings (Defra, 2005b). Other leaflets by MAFF (undated) and Defra (undated) highlight the need to regularly clean and disinfectant buildings and equipment; have pressure washers, brushes, water and disinfectant available; and make sure visitors use clean overalls and footwear before and after handling cattle. Farmers are also encouraged to keep livestock away from freshly spread slurry; fence off streams and rivers; and ensure a clean supply of fresh drinking water in troughs.

In providing this advice, the effect of all these leaflets is to attempt to create an image of a particular style of farming that reduces the risk of succumbing to a bTb breakdown. In other words, whereas the population approach in human health relies on cultural changes in lifestyle, the population approach to animal health attempts an important transformation within farming styles. Vanclay (2004) and Silvasti (2003) suggest that cultural styles of farming play an important role in guiding and constraining farmers' decision making processes and encouraging the adoption of new styles is extremely difficult. It is likely that the promotion of biosecurity faces the same challenges, particularly where social research has not been used to identify appropriate agricultural extension messages (Vanclay, 2004).

These are not the only ways in which advice is communicated to farmers, but it is the main way by which the state has sought to publicly communicate this advice. However, it is also likely that general biosecurity advice is passed on by other actors, including: veterinary practitioners, trading standards officers, social networks and the farming press. Moreover, the high-profile debate about bTb has meant that biosecurity has also been promoted by scientists, politicians and policy makers, and stakeholders within various media. The Badger Trust (2007), for example have argued that electric fencing around farms may provide greater benefits than culling badgers. These activities may be seen as forms of dissemination to popularise specific scientific results (Hilgartner, 1990) similar in style to the population approach.

Biosecurity and candidacy: explaining farmers' understandings of bovine tuberculosis and biosecurity

The lesson of the prevention paradox suggests that care needs to be taken when using a population approach to manage and promote animal health. The remainder of this paper attempts to show the extent to which these lessons apply to the communication of bTb biosecurity advice. Firstly, methodological details are provided; secondly, I explore farmers' understandings of bTb and biosecurity; and thirdly, I show the social and natural consequences of the 'ecological paradox' inherent to the population approach to biosecurity.

Methodology

Data are drawn from 61 in-depth interviews with farmers in England and Wales conducted during 2006 and 2007. Fieldwork was undertaken in two case study areas (Devon and Monmouthshire), chosen as examples of areas at high risk from bTb – farms within these areas are required by Animal Health to regularly test for bTb[1]. These areas allowed access to farmers with experience of dealing with endemic animal disease. Farmers were selected according to purposive criteria, including: those farms under bTb restrictions; farms with new cases of bTb; farms that had always been clear from bTb; and farms that had implemented forms of biosecurity. This data are not freely available: research participants were therefore identified with the help of local vets, other agricultural gatekeepers, and social networks. To limit the possibilities of bias, the sample was also supplemented by contacting other farmers according to other criteria, including: farm type; and geographical location. In Devon, 30 farmers participated in the research, and 26 were drawn from Monmouthshire. The sample was supplemented with a further 5 farmers from farmers in a third region (Gloucestershire – also a high risk area) who had adopted unique biosecurity solutions. In total, 28 farms were suffering from bTb at the time of the research, whilst 53 had suffered it in the past. All interviews were semi-structured, recorded and transcribed. Participants were assured of confidentiality and anonymity at all stages of the research. Interview data were also supplemented with other ethnographic data from conversations and participant observation with farmers at markets and abattoirs and during farm tours and bTb tests. These observations were recorded in a field diary. Analysis of all data was achieved using the qualitative data analysis software Nvivo.

Candidates for bTb

Farmers use the candidate system to explain animal health in a similar way to which it is used to explain human health. They create candidates (of farmers, cows and badgers) by themselves and within their own cultural environment. Thus, stories of bTb candidates circulate around farming communities, creating and perpetuating beliefs about bTb. Firstly, farmers use the candidate system to retrospectively explain why they or their neighbours have suffered a bTb breakdown. Farmers might explain their bTb breakdowns on the use of risky practices that contravene government biosecurity advice, such as placing cattle feed on the ground or leaving mineral blocks in fields. In doing so farmers mobilise an image of a poor farmer whose practices inevitably lead to bTb:

> "I don't feed animals on the ground because I know of another farmer that fed all his animals – his young stock – whilst they were out…and he trough fed them, not on the ground but he did trough feed them and he saw badgers trotting over to clear up what the cows had left so and probably cough in the trough and that's that!"

> "There's a guy back here … it's a chap that has rented it for the summer, the silly sod was feeding nuts out into the autumn, we could see the badgers going there and sure enough he has gone down and that's where he picked it up from because he's feeding out there which is a worry because it now means we have got it back down here"

Farmers may also refer to cattle factors to explain their bTb breakdowns. Farmers rarely see advanced cases of bTb and can therefore rely on few physical characteristics. Instead, they associate bTb incidents with the periods when cattle may be under stress:

> “All the youngsters, generally all the youngsters and it's I think part of it is stress of they've just come back from the other farm, they've just had a calf, they are under stress, aren't they? Whereas the old cows seem to have built up immunity”.

Alternatively, farmers may suggest a genetic link between some cattle and bTb, such that bTb may run through lines of cattle. For these cattle, there is a sense that bTb is unavoidable. For example:

> “you will lose certain families...In this last test we had 3 daughters of 1 cow are on the inconclusive list.

Secondly, farmers may try to predict who is likely to go down with bTb based on the way neighbours farm. This may relate to management practices, such as where people source replacement stock. Alternatively, farming ability is a key part of the candidate system: “hobby farmers”, for example, are believed by many other farmers to not have sufficent knowledge to farm properly:

> “One neighbour down there he just buys in from an old dealer and I wouldn't want anything that came off there”

> “[you get] the sort of hobby farmer…who really don't have a clue, they don't know about any of these things, they think you have the cow, stick it in a field and that's

> it... they wonder why they can't hire in bulls any more and you say well because it's a bit of disease risk. Is that so they say, you know?"

Other candidates include: dairy cattle because they spend longer on farms; intensive farming systems because of the stress they put their cattle under; and management styles such as the New Zealand system where cattle are out all year round. This is seen as a risk because cattle are under stress, not eating properly and therefore likely to eat "infected" grass. For example:

> "Well the thing is these cows graze that tight and the whole system is based on grass, they sit and wait for the grass to grow and so you are going to get such a… a lot of my cows wouldn't… my cows where a badger had been they are that fussy they most probably wouldn't graze because we feed them with a mix every day of the year so they are never hungry-hungry, but these cows have to eat grass and that's why"

Similarly, growing maize is a contested issue amongst farmers because it attracts badgers to feed off. Some farmers blame others for bTb breakdowns according to how and where they grow maize. For example:

> "my neighbour went down with his pedigree Hereford's – he doesn't grow any maize on the farm except he put a game strip [of maize] right above a field right by his house which runs right along the top of two of his buildings… The cattle grazed against it and ran right up to his buildings. He went down with a massive amount [of bTb because] his badgers… travelled to him for his maize. So I look at him and think good God he is smoking 60 fags a day by doing that - how

> stupid! But that's a bit like telling somebody in the 50s that smoking was bad for you".

Thirdly, the candidate system is used to assess one's own risk. In this, farmers may assess their risk status as high if they have a 'flying herd' and if they show cattle (herds that mainly purchase replacement stock are known as 'flying herds'). For example:

> "what worries me is the fact that I buy cattle in to finish, if I'm buying them from 12 months old they will be here until 30 months, so they are here quite a long time, it's the fact that I am susceptible to buying in… I'm a big risk factor because I'm buying in where I don't necessarily; I don't know necessarily where they come from. I will know from their passport and everything after I've bought them in auction but I don't know before"

Farmers also talk about the geography of their farm as being a factor in going down with bTb. Particular fields are said to be 'dodgy' or safe; farms either side of natural boundaries are said to be susceptible to bTb or not; and land type also seems to be a factor for some. Finally, farmers point to particular types of badgers and their behaviours as suggesting that a particular farm is at risk. Farmers' characterise the badger as a particularly intelligent and tough animal, one which many have respect for. At the same time, these characteristics mean that no biosecurity measures could ever separate them from their cattle. A sure sign of an imminent bTb breakdown is spotting so-called "rogue badgers" wandering around during the day or finding badgers in cattle sheds. Some farmers will suggest that badgers living in particular setts are those that are infected, and target those for (illegal) eradication. The same farmers might also point to sudden localised declines in badger populations as a signifier of bTb infection within the badger population which also alerts them to dangers of new badgers moving in to the area. Either way, farms in these areas are at risk from going down with bTb. Alternatively, other farmers will suggest that badgers on their land must be "clean" because they have yet to suffer a bTb breakdown. For these farmers, the last thing they would countenance is any illegal removal of the badgers. To do so would disrupt badgers' social territories, allowing new and potentially infected badgers onto their farm. Farmers, though, who have "taken matters into their own hands" and encouraged perturbation will have their breakdowns explained by their actions:

> "we had a spell when all the farms that belong to that Valley went down, what happened some silly sod up the Valley out of frustration put slurry down a sett and all he did was move all those badgers on and infected everybody else"

<u>Luck and fatalism</u>

The population approach follows similar top-down scientific styles of communication in which the public – in this case farmers – are presumed to be deficient in knowledge and need educating (Wynne, 1991). However, the candidate system highlights the range of factors farmers associate with incidents of bTb, but also their knowledge of potential adaptive behaviour. This research shows that in many cases, farmers are aware of many of the risk factors associated with bTb. Nevertheless, this knowledge does not encourage changed animal health practices. This is because just like the use of the candidate system to explain human disease, farmers recognise the system to be fallible. Indeed, if there is one thing that characterises farmers' understandings of bTb, it is that there is not much they can do about – it is purely down to luck. The importance of luck originates in all the exceptions to the biosecurity rules advanced within the population approach that farmers experience. The common example is the 'closed herd' (a herd that breeds its own replacement stock is known as a 'closed herd'). According to the general risk factors within Defra's advice, closed herds are less likely to suffer from bTb. Farmers though will point to numerous examples of closed herds suffering from bTb breakdowns to demonstrate that it offers few guarantees:

> "My cousin has a closed herd – it has been completely closed for 20 years now, they are good farmers, but they have spent thousands of pounds over the last nine years because of TB. It throws cattle to cattle transmission out of the window"

The use of the closed herd also offers a good example of the importance of understanding the cultural significance of biosecurity language. Firstly, for many farmers, the concept of biosecurity is associated with highly intensive, factory farming. The idea of trying to turn the farm into a "Colditz"-like fortress, whilst not only impossible, was also contrary to their aim of farming to preserve a particular kind of landscape and husbandry (cf. Silvasti, 2003). These cultural connotations of biosecurity, combined with these styles of farming led to the rejection of biosecurity, but also link back to concepts of luck and fatalism to reinforce the legitimacy of traditional management techniques.

Secondly, scientists propose a binary classification of either closed or flying herds, but argue that farmers 'claim to have a closed herd, but they simply do not exist' (Bourne in Defra, 2004a: 14). This misunderstands the meaning farmers imply to a closed herd. Farmers refer to the closed herd as a fluid entitity, rather than the binary terms envisaged by scientists. Thus, whilst some farmers will claim definitively that they have a closed herd, others will describe themselves as "nearly closed" or "90% closed". What they refer to here is the process of becoming a closed herd, a process which is a valid state, and not one equivalent to routinely buying in replacement stock (i.e. a flying herd). In this, farmers will also recognise that maintaining a closed herd is difficult and there may be times which require emergency restocking (e.g. if a calf dies) or to help manage the characteristics of the herd (e.g. bringing in a new bull). Neither situation compromises the status of the closed herd because it is constantly in the making. This more finely grained classification of herds therefore points to the need for a different language. One which imparts only binary classifications would seem, in this case, liable to be misunderstood.

The uncertainties provided by a closed herd reinforce farmers' views that contracting bTb is a matter of luck. Luck is also generated by observations of unwanted and unwarranted cases of bTb. Thus, farmers judged to be excellent by their peers are just as likely to suffer from bTb as those judged as poor. Equally, it is those "high risk farmers" (farming's equivalent of 'Uncle Norman') that never suffer bTb whilst the "good ones" (equivalent to human health fanatics) do:

> “This bloke is buying them all the time and he has never gone down and he has bought from TB infected herds or herds that have passed the test to be sold. He has bought them there, takes them home and he has never had one go down. So no, I don't think anybody can be blamed for getting TB.”

There are unwarranted and unwanted exceptions within cattle too: where it seems likely that cattle-to-cattle transmission should have occurred, farmers often point to these cases to show that the theories of cattle-to-cattle transmission within the population approach provide no guarantees or can be trusted. For example:

> “you cannot have this heifer spewing TB, I mean like they told us to go to the doctors. She was so bad we had her shot on the farm. Something like that fair enough, she will pass it about and we know – but she hadn't done though and she was in with [all the other] cows”

This meeting of the spatial logic of the population approach and farmers’ experienced reality of official attempts to control bTb therefore inspires a sense of fatalism. For many farmers, bTb is described as like a game of ‘Russian roulette’. Fatalism derives from the sense that bTb has become a way of life: it is no longer a surprise if they contract bTb and there is little motivation to do anything about it:

> “people have got to that point now that they think it’s continuous…you don’t get over it, it’s not like Foot and Mouth where you get it and then you’re clear and you don’t have it again. But with TB it’s a continuous thing that you’ve got that 6 month period where you’re clear and then you’re down again”.

> “it would be better if you were doing your biosecurity or doing things to prevent TB and they were working but what you do to prevent it doesn’t seem to really have any effect on what rate of TB you go down with.”

Farmers therefore suggest bTb has become a way of life: it is as “common as catching a cold”, or “like a cancer that never goes away”. Some farmers become stressed by this: they see no way out, their business is tied up by restrictions and they commit desperate acts. This includes the illegal culling of badgers and even keeping valuable cattle in sheds all year round out of fear that they might contract bTb. Farmer suicide can accompany bTb breakdowns. Some farmers therefore help others to “take care of wildlife” – a euphemism for illegal badger culling – out of a concern for people and communities. Said one farmer:

> “Id rather someone shoots a badger than they shoot themselves, and that’s why I’ve done it for people…what I can tell you is this: that there might be somebody out there now that might be still here because of something I'd done and that's enough for anybody”

These actions provide a feedback mechanism to the candidate system. Where farmers’ bTb problems have been resolved following badger culling, their cases are held up as examples of success – the ‘Uncle Normans’ of agriculture who contravene animal health advice yet whose situation somehow improves. The circulation of this knowledge within local agricultural communities reinforces their actions as legitimate. However, such options are not open to all farmers. The illegality of badger culling obviously puts some farmers off. But those farms in isolated areas, away from the edge of nearby towns or areas with a high number of wildlife enthusiasts are more able to act upon these lay epidemiologies (cf. Neal and Walters, 2007).

Other farmers respond to bTb by adapting their farming practices following a positive test: they are in a “state of readiness” to match their farming system to the demands of being under bTb movement restrictions. To prevent over-stocking, dairy farmers may begin shooting bull calves at birth and/or finish cattle for beef. Again, these are not options open to all farmers, neither are they adopted easily: they may run contrary to farmers’ own cultural sense of what constitutes good farming (Silvasti, 2003). However, the over-riding sense of fatalism does not drive them to implement new biosecurity measures: that would be just too open to chance. Even for those farmers who have constructed electric fences around badger setts, there is little sense of achievement. Their failure in combating bTb adds to the stories circulating in the farming community that feed the ecological paradox.

Instead what farmers do is rely on their own lay epidemiologies and management practices. In practice that means illegal badger culling; missing or delaying bTb tests; and compromising existing biosecurity regulations, such as isolating bTb infected cattle before their slaughter. The decision of where to buy new cattle from is also structured by the reliance on lay epidemiologies. Farmers may be discouraged from buying from herds in low risk bTb areas because the stress of moving cattle long distances may make them susceptible to bTb when they arrive in a high risk area. Equally, lay epidemiologies may encourage farmers to restock from areas with high bTb because of beliefs in immunity and susceptibility gained by cattle living in high risk areas:

> "you would be more likely to buy things closer to home from a local supplier off local farms because they are more likely to stay clear – you are likely to be better off. There seems to be greater immunity to the local cattle to ones from other parts of the country"

These lay epidemiologies and the dominance of fatalism mean that there seems little point in adopting new biosecurity practices. It should be recognised that other factors also drive this behaviour, but they are not unconnected to the problems of the population approach. In particular, farmers have low levels of trust in Defra. This originates in the perceived mis-handling of recent agricultural crises (such as Foot and Mouth, and the problems over the establishment of the Rural Payments Agency). But in relation to bTb, the loss of trust stems from farmers' experiences of Defra and the ISG's experiment to assess the role of badgers in the epidemiology of bTb. In following the experiments, the social and political construction of science was made obvious to farmers. Firstly, the government made it clear from the outset that a policy of widespread badger culling would not be acceptable (ISG, 2007). Secondly, farmers within the trial areas suggested that the culling trial had been extremely inefficient (EFRA, 2006). Thirdly, farmers claimed that they were simultaneously told in public meetings organised by the scientists that the trial would require all badgers to be eliminated in some trial areas but that complete elimination would be impossible to achieve (cf. Wynne, 1992).

Farmers interviewed in and around the trial areas were therefore ambivalent to its results. For them, it was undermined from the start and worked for conservation rather than agricultural interests. This was symptomatic of a rural politics that viewed the countryside as under attack from urban values by “people sitting in London who know little about the reality of farming” (cf. Bickerstaff et al, 2006). These criticisms are also relevant to the practice of the population approach. Firstly, it shows how styles of reasoning conjoin political ideologies and spatial identities (cf. Bickerstaff and Simmons, 2004). Secondly, it reveals how lay epidemiologies are developed not just in relation to the communication of health advice, but through observations of the ways and terms by which those data that underpin the population approach’s prescriptions are collected. In fact the perturbation effect – deemed to undermine the utility of badger culling by the ISG – has long been part of farming folklore through farmers own situated observations of badger behaviour. As demonstrated above, farmers use the candidate system for badgers too: those that look healthy and live on bTb-free farms are actively protected by farmers because of the deterrent these ‘healthy’ badgers serve to those infected with bTb. That this understanding became scientifically codified as ‘perturbation’ merely undermined the epidemiological basis of the population approach: it reinforced the view that the scientists did not do their job properly – they simply killed the “wrong” badgers – the “healthy” ones – leading to the spread of disease. That is, unlike farmers’ understandings, their approach was neither situated, contingent nor specific (cf. Wynne, 1992).

Conclusion

Farmers are fatalistic about disease because the apparent biosecurity certainties on offer are contrasted by a ‘fundamental gap which exists between a person’s experience of a given reality and science’s explanation of that same reality’ (Gifford, 1986). This gap can be traced to a clash of spatial logics inherent within the population approach and farmers’ understandings of animal health. Farmers’ own experiences of bTb tell them biosecurity solutions will not work; these conclusions are sustained by farmers’ social environment and the stories of bTb candidates that circulate within farming communities; and finally their previous experience of dealing with Defra tells them not to trust them. These findings highlight the need for animal health experts and policy makers to engage with farmers’ cultural and geographical understandings of animal disease when thinking about the promotion of biosecurity. In doing so, this engagement may firstly provide an opportunity for policy makers to reflexively think about the limitations of their proposed solutions. Secondly, engaging with these cultural understandings of biosecurity has important implications for the communication of biosecurity advice. To date, Defra has sought to promote enhanced farm biosecurity using leaflets containing general animal health messages. These findings, however, suggest that such efforts may reinforce traditionally held views of disease control and, ironically, adversely affect animal health. This then is the ‘ecological paradox’ in action: a paradox because policy achieves the wrong ends; ecological because it affects both social and natural populations; and geographical because it involves different spatial logics of understanding animal health.

These findings raise two important questions. Firstly, if these conundrums to health promotion were already appreciated in relation to human health, why proceed with a population approach? One answer may lie in the way in which Defra framed the solution to bTb and its commitment to solutions based on "sound science" (Defra, 2005a). Yet, in determining the definition of "sound science", it seems the potential contribution of social science was ignored. Whilst Defra have always insisted that any new bTb policies would have to be socially acceptable, this seems to be where any concern for "the social" begins and ends. For example, between 1996-2006, Defra spent approximately £70million on research into bTb. Only 0.1% of this was spent on social research. Similarly, a review of the evidence for bovine Tuberculosis commissioned by Defra's Science Advisory Council failed to include socio-economic research within its terms of reference (SAC, 2005). More recently Defra's Science Advisory Council (2007) have sought to enhance the role of social science within policy making. However, for bTb these recommendations are too late: its absence has meant that bTb policy is framed uniquely as a scientific and/or veterinary problem. In doing so, a range of social and cultural aspects of illness and disease are ignored. Such a scenario is not unusual. A review of the academic journals dealing with animal disease control reveals that social and cultural factors are rarely or only briefly discussed (see for example Lindberg and Houe, 2005).

Alternatively, the absence of social science may be related to organisational failings, specifically the failure to promote integrated working practices. Elsewhere in Defra, the social sciences have played an important role in helping to design policies and strategies to influence pro-environmental behaviour (Defra, 2004b, 2006a,b). Thus, the styles of reasoning associated with animal health problems may have contributed to a set of 'institutional logics' (March and Olsen, 1992) within Defra that lock traditional approaches and disciplines to solutions (cf. Ward et al, 2004). It may take some radical re-organisation of structures and institutions if these challenges to the social organisation of risk management are to be avoided, but it may also begin to address the corrosive loss of trust between farmers and government. Government attempts to change behaviour and develop 'ownership' of bTb through encouragement rather than regulation therefore require greater recourse to social science, to highlight both problems and opportunities – a call to which human geographers are ideally placed to respond (see Herrick [2007] for a similar argument in relation to public health).

Secondly, if biosecurity remains a worthwhile endeavour, how is it possible to encourage farmers to adopt biosecurity? Even with fairly reliable technologies, agricultural sociologists have shown how cultures of farming make technology transfer a difficult task (Vanclay, 2004). For biosecurity, this is made more difficult because all aspects are precautionary and some have little or no scientific proof that they "work". In fact, proving that biosecurity "works" is incredibly difficult, particularly with a multi-factorial disease like bTb. With Defra saying that policy should be based on "sound science", the lack of scientific knowledge on the effectiveness of biosecurity suggests that its popularisation may be a form of discursive 'pollution' serving to amplify the risks associated with bTb (Hilgartner, 1990). Perhaps it would be better not to speak of biosecurity at all, at least not in the terms Defra have adopted?

It would also be wrong to rely only on “sound science”, even if it existed for biosecurity. Instead, as this paper argues, the problem relates more to developing the cultural conditions in which farmers can constructively learn and apply biosecurity. In many ways it is pointless recommending biosecurity if farmers cannot afford it or have limited support to personally advise them (cf. Pannell et al, 2006). What studies from the sociology of health and agriculture have shown is that behavioural change initiatives are more likely to succeed by working with rather than against popular culture (Backett and Davison, 1992). What this means is acknowledging the importance of the socialisation of health (Davison et al, 1991). The candidate system that farmers create does recognise the risk factors that are also identified within scientific discourses. There are some biosecurity activities that farmers do implement from which they create their own codes of appropriate behaviour (e.g. not putting mineral blocks out, not feeding on the floor etc.) although by no means do all farmers subscribe to these and in all cases it is mediated by local experience and observation. In this way, the candidate system does not merely operate as a means to propagate a set of rural myths. Rather, the challenge lies in working with these cultural understandings of disease to help understand how biosecurity can achieve cultural currency within the farming community. Why some aspects of biosecurity have already achieved this is unclear: the ignorance of social research within bTb policy has meant that this is unknown.

The reluctance to take social research seriously, learn from other social theories of health promotion and include it within definitions of “sound science” has meant – despite any best intentions – the implicit promotion of the ecological paradox. There are a number of other ways of promoting animal health. The development of social learning to encourage the appropriate conditions for farmers to establish their own solutions may offer some hope (Röling and Wagemakers, 1998). Such methods have been used to help promote agricultural efficiency but not, it seems, address bTb. Thus, if Defra are serious about encouraging 'ownership' of bTb amongst the farming community, then it is these social aspects of disease control that need to be understood and evaluated. However, for as long as bTb is framed as a uniquely veterinary or scientific problem and fails to engage with the social understanding of bTb the consequences for cattle, farmers and badgers will be severe.

Notes

[1] Animal Health (formerly known as the State Veterinary Service) is the UK Government's agency responsible for the delivery of bTb policy. It determines the frequency of bTb testing for individual farm parishes by assigning each a parish testing interval (PTI). These intervals can range from one to four years but farms within high risk areas may expect to test more regularly, either due to bTb incidence on their own farms, as a result of neighbouring farms contracting bTb, or as a result of cattle tracings – where cattle have been moved from one herd which subsequently contracts bTb, cattle may be retested at their new location to prevent transmission within that herd. The farms that participated in this research were all in annual parish testing intervals.

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