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1 **Broken biosecurity? Veterinarians' framing of biosecurity on dairy farms in England.**

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10 qualitative

11 **ABSTRACT**

12 There is seen to be a need for better biosecurity – the control of disease spread on and off
13 farm – in the dairy sector. Veterinarians play a key role in communicating and implementing
14 biosecurity measures on farm, and little research has been carried out on how veterinarians
15 see their own and farmers’ roles in improving biosecurity. In order to help address this gap,
16 qualitative interviews were carried out with 28 veterinarians from Royal College of
17 Veterinary Surgeon farm accredited practices in England. The results were analysed using a
18 social ecology framework and frame analysis to explore not only what barriers vets
19 identified, but also *how* vets saw the problem of inadequate biosecurity as being located.

20 Veterinarians’ frames of biosecurity were analysed at the individual, interpersonal and
21 contextual scales, following the social ecology framework, which see the problem in different
22 ways with different solutions. Farmers and veterinarians were both framed by veterinarians as
23 individualised groups lacking consistency. This means that best practice is not spread and
24 veterinarians are finding it difficult to work as a group to move towards a “predict and
25 prevent” model of veterinary intervention. But diversity and individualism were also framed
26 as positive and necessary among veterinarians to the extent that they can tailor advice to
27 individual farmers.

28 Veterinarians saw their role in educating the farmer as not only being about giving advice to
29 farmers, but trying to convince the farmer of their perspective and values on disease
30 problems. Vets felt they were meeting with limited success because vets and farmers may be
31 emphasising different framings of biosecurity. Vets emphasise the individual and
32 interpersonal frames that disease problems are a problem on farm that can and should be
33 controlled by individual farmers working with vets. According to vets, farmers may
34 emphasise the contextual frame that biosecurity is largely outside of their control on dairy

35 farms because of logistical, economic and geographical factors, and so some level of disease
36 on dairy farms is not entirely unexpected or controllable. There needs to be a step back within
37 the vet-farmer relationship to realise that there may be different perspectives at play, and
38 within the wider debate to explore the question of what a biosecure dairy sector would look
39 like within a rapidly changing agricultural landscape.

40

41 **Introduction**

42 In an agricultural context the term “biosecurity” refers to practices that control the spread of
43 disease both onto and within the farm (Dargatz et al., 2002). Instances of certain common
44 livestock diseases have increased in recent years and it is widely claimed that better
45 biosecurity practices are needed to improve animal welfare and enhance the financial
46 viability of the dairy sector in the UK (Defra et al., 2004). The 2004 Animal Health and
47 Welfare Strategy for Great Britain emphasised the responsibility of animal owners in
48 managing animal health risks and stated that veterinarians (hereafter referred to as “vets”)
49 are uniquely placed to promote animal health and welfare and should be at the forefront of
50 delivering proactive disease prevention services (Defra et al., 2004), a point which is
51 reiterated in a European context (European Commission, 2013). Yet research suggests that
52 uptake of biosecurity measures on dairy farms is low with certain practices being very rarely
53 carried out (Sayers et al., 2013; Brennan and Christley, 2012; Nöremark et al., 2010).

54 Research in the UK and Ireland suggests that despite low uptake of biosecurity practices,
55 dairy farmers do see biosecurity as important (Heffernan et al., 2008; Sayers et al.,
56 2013; Brennan and Christley, 2013). Vets have been identified as one of the most important
57 (Gunn et al., 2008; Derks et al., 2012) and most reliable and credible sources of information
58 for farmers on biosecurity (Garforth et al., 2013).

59 There has been little research done on vets’ views of biosecurity; their perceptions of their
60 and farmers’ roles in biosecurity. Previous work on the vets’ role in biosecurity has mostly
61 used quantitative surveys and identified lack of time; lack of knowledge; a belief that farmers
62 are not willing or financially able to introduce biosecurity measures; vets thinking farmers
63 already had a protocol in place; farmers not asking about biosecurity; vets not seeing
64 themselves as the primary source of biosecurity information; and vets not being specifically

65 paid for advising on biosecurity measures, as barriers to increased veterinary involvement (
66 Gunn et al., 2008; Sayers et al., 2014).

67 There have been more studies carried out within veterinary epidemiology on farmer's
68 attitudes towards biosecurity and barriers to improving biosecurity (Heffernan et al., 2008;
69 Garforth et al., 2013; Alarcon et al., 2014). The majority of studies on biosecurity within
70 veterinary epidemiology draw on socio-cognitive frameworks, of which there are numerous
71 different types, Michie et al. (2011) state there are at least eighty three different theories. The
72 most commonly used in veterinary epidemiology are the Health Belief Model (Valeeva et al.,
73 2011) Theory of Reasoned Action (TRA) (Gunn et al., 2008; Garforth et al., 2013; Garforth,
74 2015) and Theory of Planned Behaviour (TPB) (Ellis-Iversen et al., 2010; Alarcon et al.,
75 2014; Garforth, 2015). These theories focus on the individual, in this case the individual
76 farmer, as the locus of behaviour change to bring about the desired outcome: improved
77 biosecurity. Appendix 1 shows the frameworks used in a number of papers on biosecurity in
78 veterinary epidemiology.

79 There are debates about the merits of socio-cognitive theories such as Theory of Planned
80 Behaviour (Ogden, 2003; Ajzen, 2014; Sniehotta et al., 2014). Some claim these theories are
81 methodologically flawed in terms of validity, utility and coherence (Sniehotta et al., 2014).
82 One criticism concerns the role of context and “external” forces in socio-cognitive theories.
83 Within these frameworks, context and circumstances that the person acts within are relevant
84 only to the extent that they influence their intention and the socio-cognitive constructs which
85 make this up. The theory of planned behaviour for instance holds that an individual's
86 behaviour is influenced by their intention to act, which is determined by their attitudes; their
87 subjective norms – the person's perception of the social pressure to perform or not perform
88 the behaviour; and perceived behaviour control – the perceived ease or difficulty of

89 performing the behaviour (Ajzen, 1991). Some claim that it has been shown these constructs
90 cannot adequately account for the importance and influence of the person's context, as
91 contextual factors are not adequately translated into the constructs of attitude, subjective
92 norms and perceived behaviour controls (Sniehotta et al., 2014).

93 Some also state that approaches which focus on individual behaviour alone as the locus of
94 change are politically as well as methodologically problematic (Shove, 2010). Individual
95 socio-cognitive approaches put the onus for action on individuals and ignore wider systematic
96 and political change potentially involving greater buy-in and investment from government,
97 industry and other sectors (Shove, 2010). These approaches frame the problem and the
98 solution as existing with the individual and other factors are only relevant to the extent that
99 they influence the individual.

100 One approach which goes beyond an individualistic account of behaviour is a social ecology
101 approach to health promotion. Ecology is a discipline that studies the interaction between a
102 biological organism and its environment (McLaren and Hawe, 2005). This perspective has
103 been extended to the field of human health (Bronfenbrenner, 1996; Egger and Swinburn,
104 1997; Lake and Townshend, 2006; Panter-Brick et al., 2006) and to veterinary medicine
105 (Ellis-Iversen et al., 2008; Sawford et al., 2013) in order to explore the role context plays in a
106 determining individual's and group's health. An ecological perspective has also been used to
107 explore differences in the results of policies to cull badgers to combat bovine tuberculosis
108 (bTB) in the UK and Ireland (O'Connor et al., 2012). In the social ecology approach the
109 individual is not viewed separately from their context, but rather behaviour is determined by,
110 for instance, intrapersonal, interpersonal, institutional, community and public policy factors
111 (Green et al., 1996). Such perspectives widen the scope for analysis as context and
112 circumstances are not transformed into cognitive constructs that fit the model.

113 This paper will adapt a social ecology perspective to explore vets' perceptions of barriers to
114 better biosecurity in the dairy sector in terms of individual, interpersonal and contextual
115 scales (Green et al., 1996). Individual framings of barriers see the problem – inadequate
116 biosecurity – as having causes that originate within the individual and as requiring solutions
117 that are targeted to individuals. Interpersonal barriers are seen as existing at the level of the
118 relationship between people or groups of people and solutions as needing to be targeted to
119 this level. The context will be divided into the physical environment, which consists of the
120 geographical, architectural and technological context; and the social environment which
121 includes socio-cultural, legal, political and economic factors (Stokols, 1992). Here barriers
122 may be framed as outside one person's, or a group of people's control, but requires more
123 systematic or structural change.

124 The paper will use frame analysis to explore how the problem of poor biosecurity is framed
125 as existing at individual, interpersonal and contextual scales. The term frame analysis has a
126 long history in social science research, going back to one of the leading figures in sociology
127 and anthropology; Goffman (1974). In research, a frame can be understood as a cognitive
128 lens through which people order and represent ideas, or as a way in which people negotiate
129 interaction (Dewulf et al., 2009). This paper uses the term frame in the former sense as an
130 interpretive lens through which people see and represent reality, which draws our attention to
131 particular aspects and leaves others out (Entman, 1993). According to Entman frames
132 diagnose a problem, suggest causal explanations, make moral judgements and suggest
133 remedies. Frame analysis is used within the social ecology perspective because the social
134 ecology perspective allows a problem to be approached from different angles: at the
135 individual, interpersonal and contextual scale. Scales can be defined as “the spatial, temporal,
136 quantitative, or analytical dimensions used to measure and study any phenomenon” (Gibson
137 et al., 2000, p.218, as cited by van Lieshout et al., 2011, p.3). Frame analysis is particularly

138 useful in this analysis because it does not involve making judgements about how “true” or
139 “accurate” those frames are, but rather it explores the different ways people view an issue
140 simultaneously, which may be conflicting or complementary. This paper will explore the
141 framing of biosecurity at the individual, interpersonal and contextual scale. Thus stating that
142 biosecurity is framed by vets at an interpersonal or contextual scale means not only that the
143 barriers to a problem are located at these scales but that the *problem itself* is being located at
144 this scale. The idea being that one must first understand how people view a problem – where
145 they see it as located, before it can be tackled.

146

147 Frame analysis has been used previously to explore the scale at which an issue is framed and
148 the significance of this scaler framing in wider debates (Kurtz, 2003; van Lieshout et al.,
149 2012, 2011). Frame analysis has been used in an agricultural context on various topics
150 including agricultural controversies in the UK media (Naylor et al., 2015; Nerlich, 2004;
151 Nerlich et al., 2002), the framing of antimicrobial resistance in agriculture in the UK media
152 (Morris et al., 2016); Bovine Spongiform Encephalopathy (BSE) in the Canadian (Davidson
153 and Bogdan, 2010); and German media (Feindt and Kleinschmit, 2011). As well as exploring
154 the framing of food security (Mooney and Hunt, 2009), planned mega farms in the
155 Netherlands (van Lieshout et al., 2011) and a novel hen husbandry system in the Netherlands
156 (Zwartkruis et al., 2011). Several of these studies use frame analysis to explore the framing
157 of issues in the media, however frame analysis has not yet been used to explore how vets
158 perceive biosecurity and the possibility of improving biosecurity.

159 The aim of this study was to use a social ecology perspective on health promotion to explore
160 how vets frame biosecurity on dairy farms using data collected through qualitative interviews
161 with a purposive sample of farm animal vets in England. The study aims to shed more light

162 on the discussion and, through the use of frame analysis, show where areas of
163 miscommunication or disagreement may exist that need to be addressed before “barriers” can
164 be overcome in any straightforward fashion.

165 **Methods**

166 *Data Collection*

167 Data was collected through 28 semi-structured interviews with practicing vets in the UK.

168 Purposive sampling was used to maximise the range of views accessed (Bryman, 2001).

169 Qualitative interviews are normally carried out with a smaller sample than quantitative data

170 and aim to provide in depth insights into the meanings and beliefs behind people’s actions

171 and decision making, rather than produce results that can be statistically generalised to a

172 particular population (Sawford et al., 2013). With qualitative research it is the

173 appropriateness of the sample for answering the research question rather than the size of the

174 sample that matters (O’Reilly and Parker, 2013). Vets were chosen through practices which

175 were Royal College of Veterinary Surgeons (RCVS) farm accredited. The RCVS describe

176 farm accreditation as: For Farm Animal practices, the standards reflect both the requirements

177 of a primary care practice which promotes the achievement of high standards of clinical care,

178 and also a proactive approach to management, through the use of health planning, client

179 training and communication (RCVS, 2012 p.1) .

180 Vets from English counties with high density, with more than 120,000 cows and more than

181 400 holdings; medium density, with between 20,000 and 119,999 cows and between 100 and

182 399 holdings; and low density with less than 20,000 cows and up to 99 holdings of dairy

183 herds were chosen using data from DairyCo (2013). It was hypothesized that these vets may

184 have different levels of knowledge on biosecurity and be engaged in giving biosecurity

185 advice to farmers to a greater or lesser extent. Relevant veterinary practices were identified

186 using the RCVS online registration list (RCVS, 2015). The practices were contacted by
187 telephone to ascertain if they met the study criteria. From this screening process 16 practices
188 in low density, 20 in medium density and 37 in high density areas were then asked if any of
189 their farm vets would be willing to take part in the study and an information sheet and
190 consent form was provided to interviewees prior to interview. Of the 28 vets who agreed to
191 take part, 21 respondents were male and 7 female; 11 were male directors or partners, 10
192 were male assistants, 2 were female directors or partners and 5 were female assistants.
193 Interviews were conducted in person and over the phone with individual veterinarians by AR
194 over a four month period in 2014 and lasted between 40 and 75 minutes. An interview guide
195 of prepared questions was used and the interviews were semi-structured so the same
196 questions were asked but different lines of enquiry were also pursued based on the
197 respondents' answers. The interviews were recorded and transcribed by a third party and the
198 transcripts were checked against the recordings for accuracy by AR. Ethical approval for the
199 study was obtained from the School of Veterinary Medicine and Science at the University of
200 Nottingham. Data was encoded to ensure anonymity and data and recordings were kept in a
201 locked filing cabinet.

202 The topics covered in the interviews that were used for the analysis were the characteristics
203 veterinarians relationship with their clients, their definition of biosecurity, farmer's views on
204 biosecurity, the main barriers to implementing better biosecurity on dairy farms, the role they
205 played in biosecurity, what needed to change to enable vets to better support and advise
206 farmers on disease prevention and their views on the greatest risks facing dairy farmers and
207 vets.

208 *Data Analysis*

209 The analysis followed two main steps: first the data was coded using the qualitative data
210 analysis software Nvivo 10.0 (QSR, International) by three researchers independently (AR,
211 OS and JK). Data was coded using thematic analysis (Coffey and Atkinson, 1996). Coding
212 involves categorising the data according to particular themes with sub-themes within these
213 (Bryman, 2001). The codes used in this paper are the barriers that vets identified to
214 implementing better biosecurity, described in the results section below. When a respondent
215 mentioned a particular barrier it was coded under the same theme. The software allows the
216 researcher to group chunks of interview texts that are coded for the same themes together and
217 read them consecutively. Validity in qualitative research is assessed based on the force and
218 soundness of the arguments presented (Polkinghorne, 2007), as well as the thoroughness of
219 record keeping and reporting of methods in the study, and the re-coding and comparison of
220 findings between researchers (Mays and Pope, 1995). To this end the coding was checked
221 between the 3 researchers for consistency.

222 At the second stage the themes were explored using frame analysis (Virkki et al., 2014),
223 exploring how the vets viewed the particular themes. To clarify the terminology used in this
224 study: themes are particular barriers, such as financial barriers or lack of time, and frames are
225 the ways in which these themes are discussed, or the angle that is put on them, for instance as
226 legitimate, illegitimate, within or outside the farmers' control etc. Frames were identified by
227 reading through the codes and focusing on *how* that particular theme is described. Notes were
228 then made about the framing of the themes and codes were re-read to make sure that the
229 frames identified were accurate and nothing was left out. The third stage of analysis was
230 grouping these frames under the theoretical framework described in figure 1 which were used
231 in the discussion section. Data saturation was reached during the analysis. This is the point at
232 which no new information is emerging from the data (Guest et al., 2006) – where the same
233 codes are emerging from the data and the codes are being described in similar ways.

234 **Results**

235 *Inadequate biosecurity as an individual problem*

236 We will first explore how biosecurity is framed by vets as an individual problem – either the
237 individual farmer or vet’s responsibility. When biosecurity is framed at an individual scale,
238 farmers and vets are seen as responsible and capable of bringing about change and are viewed
239 as individual decision makers with their own idiosyncrasies and circumstances. Table 1
240 shows a summary of results.

241 *Farmers’ barriers*

242 *Financial Barriers*

243 Vets viewed financial barriers as being very important to farmers, and described different
244 kinds of financial barriers that farmers faced. Sometimes financial barriers were framed by
245 vets as being “legitimate” and beyond the farmers control, and sometimes they were framed
246 as more malleable and also a question of farmer prioritisation – the individual framing of
247 financial barriers.

248 Within the individual frame, farmers were framed as unwilling to spend money on
249 biosecurity, which the vet framed as a false economy and an example of bad practice by the
250 farmer.

251 Vet 16: [...] it’s just like, “Yeah, that’s a good idea”, and there’s a bargain that’s too
252 good to miss and so biosecurity goes straight out the window.

253 Here biosecurity is framed as something that will save the farmer money but the farmer does
254 not see this.

255 Vet 16: There's some of them are just quite difficult to convince that spending money is
256 the best way to stop losing money but they don't see money they've lost. They just see
257 the bill that arrived.

258 Here, a financial barrier is framed as something the individual could potentially do something
259 about – financial barriers are framed as actually being due to a lack of understanding of the
260 benefits of biosecurity or not prioritising biosecurity.

261 *Not taking the time*

262 Time was cited by the vets as one of the barriers to farmers implementing effective
263 biosecurity, as biosecurity was seen as by and large time consuming and incurring extra
264 work. Similarly to the framing of financial barriers above, sometimes this was framed as a
265 genuine case of time poverty on the farmer's part, and sometimes as a question of the farmer
266 not prioritising biosecurity – the individual frame.

267 Vet 19: I think barriers are the amount of efforts it takes, the amount of time it takes, so
268 if they take a trailer to market they do clean it when it comes back but whether they
269 clean it with anything other than a power wash or if they actually use a disinfectant is
270 another question.

271 Here biosecurity was framed as something the farmer would “cut corners” on. When asked
272 how biosecurity could be improved vet 6 stated:

273 Vet 6: Spend less on drugs, more on time. With some farmers that is still something
274 they just don't want to do.

275 When it is framed in an individual way, lack of time is again as framed as a lack of
276 understanding – of the benefits of thorough biosecurity, and a lack of farmer motivation,
277 farmers don't want to spend time on biosecurity.

278 ***Lack of education?***

279 Some vets saw a lack of education as a barrier: farmers lack knowledge of the biosecurity
280 risks they face and they lack knowledge about the measures they should implement, and it is
281 the vet's role to provide information and education.

282 Vet 34: It's just an educational thing. We're trying to do it now on all our farm talks.

283 You know just trying to bring it up, mention it all the time, so highlighting it and they
284 come in every day to get various drugs and things we've put a big banner saying
285 "Watch your biosecurity" and explain it.

286 This was not the consistent message from the data however. Other vets framed the issue not
287 as a lack of education – farmers *did* know enough about biosecurity, but that they weren't
288 putting that knowledge into practice.

289 Vet 25: I think their knowledge is probably a lot greater than the, than the actions taken
290 on it. I think a lot of them, if you were to sit them down and [...] asked them what
291 would you do to make your farm more biosecure? They could reel off a list of things
292 and they've just got lots of other things to do and they tend to slip down the priority list.

293 Vet 18 is ambivalent about the value of education:

294 Vet 18: Well maybe we could give them more information about it, maybe that's true if
295 they knew more of the detail about it but whether that would, I'm not sure even then
296 some of them would take the time to do it [...].

297 Here the problem is framed again in terms of time, or more specifically, taking the time to
298 carry out biosecurity measures, rather than an education deficit.

299 Levels of education and receptiveness of farmers to additional information or education were
300 framed by the vets as highly variable between farmers.

301 Vet 17: No I mean again it varies on farm level really, some of them are very
302 knowledgeable others aren't, so it's hard to generalise when there is such a large
303 variability on the bottom line really.

304 It was often framed as something of a mystery, why some farmers listened to biosecurity
305 advice and others didn't, vet 13 stated "I would love to know the pattern, the secret of it all
306 really".

307 While vets could not necessarily identify patterns as to why farmers didn't act, they framed
308 one of the strengths and a vital part of their role as giving individual advice to farmers.

309 Vet 19: I think that vets need to know the farm as an individual because that is vital
310 because then you can give the correct balance and bespoke advice.

311 The relationship vets built up with farmers were seen to make them well placed to get to
312 know how to pitch advice.

313 Vet 32: I can tailor that to knowing the person's character, knowing how seriously they
314 take things, knowing whether they need more evidence, whether they need more
315 anecdotes, whether they are interested in the price of it, what the drivers are, the
316 motivators are, and that's the fun in developing a relationship with your clients [...].

317 Thus many vets were ambivalent about the value of farmer education, as a lack of
318 information might not be the real problem and additional information might not be taken on
319 board. The real issues were framed rather as a lack of time or motivation. Farmers' levels of
320 knowledge and receptiveness to advice were framed as very variable and something of a
321 mystery, but within this vets framed themselves as well placed to work with farmers as
322 individuals with different needs and values.

323 ***Individual vet barriers***

324 Vets interviewed generally saw themselves as having an important role in promoting good
325 biosecurity on the dairy farms they worked with. All of the vets appeared to be invested in the
326 biosecurity of their dairy farms, often expressing strong emotions including frustration that
327 they could not bring about more change. They identified several barriers in their own role in
328 improving biosecurity.

329 *Lack of knowledge and cohesion*

330 In a few, though not many cases, vets were framed as lacking sufficient knowledge on
331 biosecurity.

332 Vet 6: I think people just don't feel comfortable sometimes with a mastitis problem,
333 "well they're the mastitis vet in the practice, ask them, I'm the fertility one". Sometimes
334 there is a perception that, "that's not my area that I like" [...].

335 Somewhat more common was the idea of there being a lack of cohesion and consistency
336 among vets on what best practice is.

337 Vet 16: I suppose we have to preach the message better and collectively. Without being
338 too self-critical, we probably aren't brilliant at it as a practice compared to if you ask
339 four people the same question you'll end up with five answers.

340 This lack of cohesion was seen as leading to variations in practice which was seen as leading
341 to confusion for the farmer. Variation in veterinary advice and their perception of what is
342 important and effective also emerged during the interviews. For example, vet 41 stated he did
343 not recommend farmers always vaccinate for diseases not on the farm because it was not
344 good practice to "over vaccinate" cattle, whereas vet 44 stated that naïve herds should always
345 vaccinate for certain diseases. One vet framed this lack of cohesion in the veterinary
346 profession as difficult to address.

347 Vet 6: Farm animal vetting is a little bit individual, or maverick; you're on your own in
348 the car, they're your clients – “don't talk to my clients; these are my clients!” You
349 could argue that there hasn't been a culture of togetherness. It can be a bit like herding
350 cats.

351 This lack of knowledge was also framed at times as the vet not seeking out new evidence but
352 rather basing advice on anecdotal evidence of what has worked previously.

353 Vet 17: I think probably as vets we're probably quite, I think farm vets in general are
354 probably quite bad about keeping up with new research and new advice and you kind of
355 get oh well this has worked for the last five years it's going to work this time and you
356 get stuck in your rut [...].

357 This lack of cohesion and individual nature was at times framed as part of the job.

358 Vet 13: If you ask five individuals you may get five slightly different answers, I mean
359 there would be some things obviously you would get the same answer but yes their take
360 on things would be slightly different, but yes that's just the nature of the profession
361 really and our role here.

362 Here vet 13 frames differences of opinion as not necessarily being a problem, but a part of the
363 vets' role. We will return to this idea in the discussion.

364 Here vets' role in biosecurity is framed as something they as individuals need to improve on,
365 and vets' collective individualism, as it were, is seen at times as something holding the
366 profession back: vets are framed as individualistic and not trying to act as a cohesive group,
367 which impairs their ability to improve biosecurity.

368 *Not taking the time*

369 Similar to the framing of farmers above, also framed the problem as them not taking the time
370 to implement biosecurity measures.

371 Vet 25: And I think also vets, and I must say that I'm guilty of it, probably don't set the
372 best example of biosecurity when I go from farm to farm. You're often in a hurry or a
373 rush. You don't disinfect everything properly with, "oh those overalls aren't too bad, I'll
374 keep wearing those".

375 There to be variation in the types and extent of biosecurity practices the vets undertook
376 themselves on the farm, suggesting this is an individual framing. Other vets stressed the vital
377 importance of their own biosecurity measures when entering a farm, to stop the spread of
378 disease and because of the message it communicated to farmers:

379 Vet 37: I think never never taking the short cut not to wash your wellies thoroughly, is a
380 key thing. So if farmers see vets not really taking the disinfection seriously then that
381 doesn't send a very good message.

382 *Inadequate biosecurity as an interpersonal problem*

383 This section will outline the frame of poor biosecurity as a problem located in the
384 interpersonal relationship between the vet and farmer¹. Certain aspects of this relationship
385 and the interpersonal problem are seen to be within the farmer's or the vet's control.

386 *Differing values and perspectives*

387 The role of the vet in educating the farmer about biosecurity was framed in the interviews as
388 not only about the vet giving the farmer additional *information*, but in terms of the vet
389 imparting their *perspective* and *values* about biosecurity to the farmer. Some vets framed

¹ There are also other interpersonal barriers that emerged in the interviews, such as vets' views on how relationships between farmers are, between farmers and government officials, and between farmers and industry bodies seen to aid or hinder biosecurity practices. But this is beyond the scope of this paper, which focuses primarily on the role of vets in on-farm biosecurity.

390 farmers and vets as having different values and priorities around biosecurity. Vets framed
391 farmers as having a higher tolerance for the presence of disease on their farm than the vet
392 had. Vet 44 speaks in the farmers' voice to explain the idea that disease issues in and of
393 themselves were not always seen as a problem:

394 Vet 44: "[...] yes my BVD bulk milk is higher okay, but actually my cows are really
395 well, they're milking better than they've ever done and yes I have losses there but,
396 which I don't see, I can't perceive them *per se* [...] but actually in general my farm is
397 working quite well. So therefore it isn't broke do I fix it?" We will try and educate
398 them as they should be doing because they can be better again.

399 The farmer is framed as having a different way of assessing disease problems to the vet and
400 the vet tries to educate the farmer to come around to his way of seeing things. The phrase "if
401 it isn't broke don't fix it" was used by vets on several occasions to express the farmers point
402 of view. Whereas for the vet, disease problems indicate that something *is* broken and needs
403 fixing.

404 The vet also tried to educate the farmer by trying to change their perspective on how
405 controllable disease problems were. When asked who farmers tend to blame for a disease
406 outbreak many vets stated that there was no "blame culture" in farming and farmers often
407 attributed it to luck and the vagaries of farming.

408 Vet 19: They could take more control. They could take more steps about it, so if it
409 happens they just tend to blame bad luck and "that's farming for you", sort of, attitude.

410 Whereas vet 19 sees disease problems as controllable and would prefer if the farmer came
411 around to this way of seeing it in order to take control of the situation.

412 ***Role of the vet on the farm***

413 Vets also stated that many farmers did not fully understand the benefits of regular contact
414 with the vet. Vets viewed regular contact with the client and the development of a
415 functioning, trusting relationship as essential for improving biosecurity.

416 Vet 25: I think it's not understanding the input and benefits that having a regular visit
417 and a good relationship with your vet brings about.

418 For some the lack of contact was connected to the "test and treat" model where farmers only
419 called the vet out when there was a problem, to cure individual sick animals.

420 Vet 12: Unfortunately I think the huge majority of our farmers are still in, sort of test
421 and treat mode and therefore you know they are most likely to engage with what they
422 should do to prevent BVD when they've got BVD.

423 It was also stated the vets themselves also struggled to make the move from a "test and treat"
424 view of their role to a "predict and prevent" role. It was stated that vets did not take a holistic
425 preventative approach to disease prevention, and it was framed as an area vets needed to
426 improve on.

427 Vet 12: We're also a profession, I think that's got to look at itself and say "I think a lot
428 of the failings in what you want to discuss today of biosecurity, have got to be pointed
429 hard at vets really."[...] whether it's looking at something like BVD and just saying "oh
430 well just vaccinate and forget about it", you know.

431 This theme about the changing nature of the veterinary profession and how vets are managing
432 this is covered in more detail in a recent paper using the same data (Ruston et al., 2016).

433 *Communication barriers*

434 One of the most common barriers identified by vets related to communication issues on
435 biosecurity: they or other vets were described as not trying hard enough to communicate
436 about biosecurity issues or not communicating effectively.

437 The issue of not communicating well enough came in several forms: the vet wasn't
438 explaining things well enough, wasn't giving compelling enough reasons, wasn't targeting
439 his arguments to the farmer or wasn't engaging in joint decision making with the farmer.

440 Vet 7: [...] so if you work on the premise that you know if somebody does something
441 wrong generally it's because you haven't explained yourself well enough rather than the
442 fact that that's a stupid farmer, you know I don't see many stupid farmers but I do find
443 plenty of farmers where people haven't taken the time to explain well enough to them
444 that perhaps a better way might be beneficial.

445 The idea that "farmers don't like being told what to do" came across clearly. The idea that
446 joint decisions between farmer and vet were the best kinds of decisions was frequently
447 expressed in the data.

448 Vet 20: You have to see them [farmers] as a partner because if you don't, you're not
449 going to take them along with you.

450 This issue was also often traced back to the farmer's response and was framed as farmers not
451 picking up on their messages about biosecurity and so vets would become frustrated and
452 would stop trying to communicate. The phrase "banging my head against a brick wall" was
453 used on several occasions.

454 Vet 17: Probably more because I just can't cope with doing it again, sometimes I mean
455 if you've told them a lot of times and they've kind of dismissed you then sometimes you
456 do go I'm not going to bother because they'll just get annoyed about me doing it again,
457 but a lot of it is I just can't face the discussion again [...].

458 Here vet 17 implies that the vet-farmer relationship will suffer if he brings it up again because
459 the farmer will get annoyed. The main impediment to effective communication on biosecurity
460 is framed as being the farmer, and the vet is unable to overcome the farmers' disinterest and
461 loses heart.

462 Thus interpersonal barriers within the vet-farmer relationship of differing values and
463 perspectives on biosecurity, the relationship not being used as it could be to prevent rather
464 than just treat disease problems, and a lack of effective communication between farmers and
465 vets were framed alternatively as a problem the vet or the farmer was responsible for.

466 *Inadequate biosecurity as a contextual problem*

467 When biosecurity was framed as a contextual problem, it is seen as an issue that resides
468 within the larger environment vets and farmers operate in and largely outside of the control of
469 individual vets and farmers to change. We will explore this frame in terms of social
470 environment and physical environment.

471 *Social environment*

472 *Financial barriers*

473 As well as being framed an individual barrier, described above, financial barriers were also
474 framed as residing in the wider environment farmers operated within. The investment costs of
475 biosecurity measures, such as improving housing to reduce animal overcrowding, were seen
476 by some vets as prohibitive.

477 Vet 20: So, yes, money's not the only thing, it's an important thing. But it probably
478 comes into the "You should do this, you should split these cattle off." "We don't have
479 the buildings." "Why don't you have the buildings?" "We don't have the money".
480 "You should get on and vaccinate all these... however often." "We don't have the time.
481 We don't have the manpower", all comes back to money I suppose.

482 Thus while the individual framing of financial barriers framed the real problem as being the
483 farmer not understanding the importance of spending money on biosecurity, or not being
484 motivated to, here the financial barriers are framed in some sense as more “legitimate” and
485 outside the farmer’s control. Vets also stated that farmers forego expenditure on veterinary
486 services when they are under financial pressure, which vets framed as a significant challenge
487 to their effective involvement with the farmer. Vets stated that the downward pressure on
488 milk prices and loss of farmer income reduced the farmers’ ability to invest in biosecurity.

489 Vet 20: [...] when I first graduated I saw a lot of improvements in cattle welfare and
490 investment and then with downward pressure on prices over the years it certainly hasn’t
491 advanced, there’s a lot more pressure on cows and livestock these days, simply because
492 of the pressure on prices [...].

493 At other times financial barriers were framed as something closer to a market failure where
494 farmers are not adequately compensated for measures which benefit the public good as well
495 as their own.

496 Vet 44: [...] if someone achieves BVD accreditation why can’t they get, where’s the
497 added value to them? So they’ve spent all that money done that work, some will say the
498 added value to them is that their animals are healthier but they take them to market and
499 they get the same price as the bloke who’s selling a BVD animal next door [...].

500 Thus the contextual framing of financial barriers located the financial barrier to improving
501 biosecurity as largely outside of the farmer’s control: farmers did not have the resources for
502 biosecurity measures because of current economic conditions in the milk industry, and there
503 was a market failure in the dairy industry which did not create financial incentives to improve
504 biosecurity.

505 *Lack of time*

506 Lack of time was also framed as something outside of the farmer's control. One vet linked
507 lack of time to difficult financial pressures on the farmer:

508 Vet 44: Are they going to isolate a milking cow till they've got it vaccinated? You know
509 that's four weeks apart plus a week let's say, that's five weeks of isolation feeding that
510 cow separately it's just the work involved and I think, I mean obviously dairy prices,
511 milk prices well they come down three pence but you know they're being quite good but
512 historically they've been bad for quite a while so what's gone off farms? Labour, it's the
513 first thing they can ditch. You know so they do more themselves, they work longer
514 hours, they haven't got the labour or manpower to go round and so all these so they're
515 going to buy cows that need milking they're going to put them in the milking herd [...].

516 Time was also framed as an issue impeding the effectiveness of the vets' role in biosecurity.
517 In contrast to the individual and interpersonal framing, here the issue of a lack of time was
518 generally framed as something outside of an individual vet's control. It was rather a feature of
519 their job that they had other more immediate tasks to attend to than discussing disease
520 prevention and biosecurity and undertaking this role effectively. Vet 6 stated that vets often
521 did not have the time to engage with farmers on disease prevention work as the "bread and
522 butter" work of treatment and testing got in the way. Vet 32 stated he did not have time to
523 document the actions taken on farms as this would severely limit his ability to get clinical
524 work done. Vet 13 stated that vets often did not have time to explain disease control issues
525 fully to the farmer. When the issue is framed in this way it is rather seen as something that
526 needs to be tackled in the veterinary profession as a whole if vets are to become more
527 effective in improving biosecurity, a subject which is dealt with at greater length in Ruston et
528 al. (2016).

529 *Lack of biosecurity culture*

530 Though vets framed farmers at times as idiosyncratic individuals, the vets interviewed also
531 almost unanimously viewed dairy farmers as a whole as being poor at implementing
532 biosecurity measures. The most common answer to the question of what proportion of the
533 farmers they dealt with maintained good biosecurity was 5-10%. At times this overall poor
534 biosecurity was framed in terms of a lack of biosecurity culture: eight of the vets compared
535 the dairy sector unfavourably with the pig sector, which was seen as having a culture of very
536 tight biosecurity practices, which vet 4 called “a whole different world”.

537 Vet 42: In terms of, there’s probably only one guy I can think of who will insist that
538 you dip your boots before you go onto his farm. [...]. Whereas we have some pig
539 clients and it’s just, the mind-set is incredibly different.

540 Here the problem is framed as that of the farmer’s mind-set, or a collective mind-set or
541 attitude which does not prioritise biosecurity in the dairy sector.

542 *Physical environment*

543 *Logistical barriers*

544 At other times, this overall, sectoral biosecurity issue was framed not in terms of a different
545 mindset, but as due to practical, logistical barriers. Practical barriers included the physical
546 layout of the farm which was not always seen as conducive to biosecurity practices, as vet 50
547 states in relation to isolating new animals:

548 Vet 50: The main issue I see with dairy clients is that they are buying in animals to join
549 the dairy herd and it is not always possible for them to quarantine the animals and also
550 test before they arrive on the farm so that can be an issue, and they have not necessarily
551 got a place where they can house them separately and milk them separately.

552 Here the problem is framed as being outside the farmer's control, and is related to the issue
553 above that farmers also often do not have the money to invest in buildings that are more
554 conducive to good biosecurity.

555 The fact that dairy cows graze means that they have exposure to wildlife and to other cattle,
556 which is seen as difficult for the farmer to control. One vet compared the dairy sector to the
557 pig sector, and highlights how the outdoor nature of the dairy production means it is
558 inherently more difficult to make biosecure.

559 Vet 49: How do you biosecure a river or a stream? If that was the case or wild birds,
560 which as a freak example could have picked up some contaminated material and
561 dropped it on the farm so that is very hard to control again.

562 Thus a dairy industry wide barrier was framed as a question of biosecurity culture and/or
563 logistical issues.

564

565

566 **Discussion**

567 To the authors' knowledge this is the first paper that provides an in-depth analysis of vets'
568 views on biosecurity on dairy farms. The use of a social ecology perspective on health
569 promotion explored through frame analysis in this paper allows for an exposition of how
570 inadequate biosecurity is framed as a different kind of problem requiring different kinds of
571 solutions at the individual, interpersonal and contextual scale. In this section we will draw out
572 the implications of these frames and compare our results to previous literature.

573 ***Individual Barriers***

574 When inadequate biosecurity is framed at an individual scale, farmers and vets are seen as
575 individual decision makers with their own idiosyncrasies and circumstances. This individual
576 frame characterises the problem of inadequate biosecurity as, to a certain extent, within the
577 individual vet or farmer's control to change. The individual barriers within this frame were
578 farmer's financial barriers; vet and farmer lack of time; a potential lack of knowledge among
579 some farmers; and lack of knowledge and cohesion among vets. Farmer's lack of time,
580 money and knowledge were framed as fundamentally due to a lack of motivation,
581 understanding and prioritisation.

582 As highlighted in the introduction, previous studies have found lack of time (Sayers et al.,
583 2013; Hall & Wapenaar, 2012) and money (Palmer et al., 2009; Lowe, 2009; Ellis-Iversen et
584 al., 2010; Derks et al., 2012; Sayers et al., 2013; Alarcon et al., 2014) as barriers to farmers
585 implementing biosecurity measures. It is difficult to directly compare the findings of these
586 studies to our analysis as they do not use the same framework of different scales of barriers.
587 Ellis-Iversen et al. (2010) state that farmers did not see a financial benefit from investing in
588 biosecurity – similar to the individual frame identified in our study, and did not have the
589 profit margin to invest – similar to the contextual framed used in our study. Vets also
590 highlighted these issues in previous studies (Gunn et al., 2008; Sayers et al., 2013; Pritchard
591 et al., 2015). Gunn et al. (2008) found vets thought clients were not willing to invest in
592 biosecurity – the individual frame used in this study, and could not afford to invest in
593 biosecurity – the contextual frame.

594 There has been uncertainty in the literature about lack of knowledge among farmers as an
595 important determinant of implementation of biosecurity on farms, reflecting the uncertainty
596 expressed by vets in this study. Some studies have suggested that lack of knowledge about
597 biosecurity was an important reason why farmers did not implement biosecurity measures

598 (Pritchard et al., 2015; Sayers et al., 2013; Toma et al., 2013). However other work in the UK
599 (Hall and Wapenaar, 2012) and the Netherlands (Jansen et al., 2010) suggest that farmers
600 thought they had, or did have, knowledge to implement disease control.

601 Previous research has also reported vets not giving consistent advice and having
602 heterogeneity in clinical beliefs on effectiveness of strategies for disease control (Higgins et
603 al., 2014). Though it was not the most commonly cited reason in the interviews for
604 heterogeneity in veterinary advice, it has been pointed out that this might be partly explained
605 by a lack of evidence on the effectiveness of different veterinary interventions on farm
606 (Higgins et al., 2014). A study by Anderson (2010) found variation in the biosecurity
607 practices taken by vets on farms, and overall low levels of uptake of biosecurity measures.
608 Thus, interestingly, while farmers are often framed as having idiosyncrasies and being
609 reluctant to change, vets were also seen this way, as vet 6 described the difficulties of getting
610 vets to change their practice and the advice they gave.

611 When vets framed barriers in individual terms they often voiced a certain amount of
612 confusion and pessimism about biosecurity. Farmers were framed as a collection of disparate
613 individuals and it was difficult to identify patterns across their behaviour. However, within
614 this frame there were still seen to be ways to improve biosecurity measures on farms. Change
615 could be brought about gradually over time through positive contact with the vet, as vets are
616 well placed to get to know individual farmers, a point which has been reiterated in the
617 literature (Atkinson, 2010; Higgins et al., 2013). Vets' diversity and individualism is also
618 seen by vets as part of their role as identified by vet 13. This has previously been pointed out
619 by (Higgins et al., 2013) in treatment of footrot and by Enticott (2012) in relation to how bTB
620 testing protocols are applied by vets on the ground and demonstrates how the situated nature
621 of veterinary work means that any protocols or guidelines must allow a large leeway for

622 veterinary interpretation and application. In this respect, a certain amount of variation in
623 veterinary practice is seen as normal and healthy given the very individual and relational
624 nature of farmer-vet interactions.

625 Framing barriers in individual terms puts the onus on the individual to make change (Shove,
626 2010). In political terms, this resonates with how animal disease is framed in some policy
627 literature; the 2004 Animal Health and Welfare Strategy (AHWS) states “The primary
628 responsibility for the health and welfare of animals rest with their owners” (Defra, 2004 et al.
629 p.12). The AHWS set out a plan for less government involvement in on-farm disease
630 prevention and a greater emphasis on the role of individual farmers and vets, and the industry
631 to bring about change. Enticott (2014) uses the term “biosecurity citizenship” to refer to this
632 perspective (p.133). The individual framing also accords with neoliberal government policy
633 in recent years in around agriculture – of less government support for agriculture, vets having
634 a smaller public sector role and spending cuts on animal health services (England Advisory
635 Group on Responsibility and Cost Sharing, 2010; Enticott et al., 2011; Woods, 2011;
636 Enticott, 2014). With the exception of bTB, which is seen by some as a special case because
637 it is a zoonosis and its historical significance (Carslake et al., 2011), the government in
638 England, where this study was carried out, is not pursuing any ambitious farm animal disease
639 eradication programs, in comparison to state sponsored programs in Scotland, Wales and
640 Northern Ireland (Boden et al., 2015).² However, the other framings below suggest that vets
641 do not see biosecurity only as an individual problem, and other approaches are also needed to
642 effectively improve biosecurity.

² Collective action on biosecurity is however being promoted by industry bodies in the UK. In England the industry body the Cattle Health and Welfare Group (CHAWG) is leading mass biosecurity campaigns, with Defra as a contributor (CHAWG, 2016), including the extension of a BVD eradication scheme from Wales and Scotland to England (AHDB Dairy, 2015).

643 ***Interpersonal Barriers***

644 Barriers framed as existing at the interpersonal scale consisted of issues within the farmer-vet
645 relationship. In this study vets highlighted differing values and perspectives between vets and
646 farmers on biosecurity; communication problems around biosecurity; and a problem in
647 moving from a “test and treat” to a “predict and prevent” model of veterinary involvement.
648 Surveys of vets’ opinions have restated the view that the vet will give up trying to
649 communicate with farmers about biosecurity because of a belief that farmers are not
650 interested in biosecurity (Gunn et al., 2008; Sayers et al., 2014). The point made by vets that
651 they would benefit from more training communication and persuasion is also recommended
652 in the literature, particularly in relation to joint decision making with farmers (Mee, 2007;
653 Lowe, 2009; Jansen et al., 2010). The reasons why the vet would not see the farmer as often
654 as he or she would like was often seen as due to certain farmers being wedded to the “test and
655 treat” model of veterinary intervention and not appreciating the need to move to the “predict
656 and prevent” model, a point which is reiterated in the literature (Lowe, 2009; Hall &
657 Wapenaar, 2012; Orpin & Sibley, 2014). Similar the views expressed by vets in the
658 interviews, it has been pointed out that some vets may also be operating within the “test and
659 treat” model and there have been calls for reform of the veterinary profession (Lowe, 2009;
660 Kaler and Green, 2013; Woods, 2013), which is described in greater length in (Ruston et al.,
661 2016).

662 An important finding from this study which adds to our understanding of communication
663 issues between farmer and vet was that the vets’ role in educating and giving advice to
664 farmers was not only seen to be about communicating information but about the vet trying to
665 convince the farmer of their *perspective* and *values* around disease control. This issue will be

666 dealt with in more detail after the section on context, as understanding the contextual frame is
667 relevant to understanding this difference in framing.

668 When barriers are framed as existing at the level of the interpersonal barriers, the relationship
669 between vets and farmers is seen as not operating as well as it could to improve biosecurity.
670 Within this, different aspects of this relationship are seen as within the control of different
671 parties: the farmer has control over how often they see the vet, but the vet has a certain
672 amount of control over if and how they communicate about biosecurity.

673 *Contextual Barriers*

674 *Social Environment*

675 Barriers to implementing biosecurity measures were also framed by vets as operating at the
676 scale of the social context, including the economical, socio-cultural, legal and political
677 environments vets and farmers worked within (Stokols, 1992).

678 The framing of “no biosecurity culture” in the dairy sector, with farmer seen as having little
679 interest in biosecurity and little social pressure from other farmers to make change, resonates
680 with the findings of Heffernan et al. (2008) who found there to be little group cohesion or
681 appetite for collective action in the cattle and sheep farmers in the UK. Similarly, the idea of
682 there being no “blame culture” around biosecurity accords with the findings of Enticott
683 (2016) that farmers in New Zealand view luck as an important determining factor of their
684 bTB status.

685 Financial barriers were also framed by vets as a collective as well as an individual issue
686 facing dairy farmers. The public goods nature of biosecurity has been highlighted in the past,
687 with calls for this to be recognised and compensated by industry and government (England
688 Advisory Group on Responsibility and Cost Sharing, 2010), as vets in this study called for

689 more financial incentives for selling cows with high disease status. The economic conditions
690 dairy farmers operated within, especially low milk prices has previously been reiterated in
691 interviews with farmers as a barrier to better biosecurity in relation to zoonotic control
692 programs (Ellis-Iversen et al., 2010).

693 Here, in contrast to the individual frame, farmers and vets are framed as a group, with
694 common patterns identified across biosecurity barriers. At the moment there was a feeling
695 among vets that group norms in the dairy sector are not conducive to good biosecurity and the
696 economic conditions facing the dairy industry are more difficult for dairy farmers as a group
697 to influence.

698 *Physical Environment*

699 While the biosecurity culture in the dairy sector was often compared unfavourably with that
700 in the pig sector, cattle farmers have emphasized the constraints imposed on them by the
701 physical context they work within: the farm geography, technology and infrastructure
702 (Enticott and Vanclay, 2011). An appreciation of the contextual features of biosecurity which
703 are to some extent beyond individual farmers' and vets' control is important for coming to
704 terms with biosecurity (Enticott, 2008). Enticott (2008) stated that because of the open nature
705 of dairy farms and uncertainty about the effectiveness of measures, many farmers maintained
706 that disease risks could not be influenced on their farm, but a more systematic approach,
707 badger culling in the case of bTB, was needed. Vets in this study did emphasise the physical
708 contextual barriers to better biosecurity, and the only thing vets appeared to agree on was the
709 heterogeneity of the physical environment on farms and the need for farm-specific
710 approaches, which vets were well suited to adapt their advice to. However, if vets emphasise
711 the context scale frame too much this may downplay their role and potential to intervene in

712 biosecurity, and they stress that there is always a certain amount that can be done in each
713 context.

714 Using the social ecology perspective, one can compare the point that the physical context of
715 the farm makes biosecurity very difficult for some farmers, to the point made in relation to
716 obesity that some environments are more or less conducive to promoting good health – so-
717 called “obesogenic” environments can make it difficult for people to maintain a healthy
718 weight (Lake and Townshend, 2006). This raises two points – about the limits of the
719 individual and interpersonal frames to improve biosecurity on current farms, and for the need
720 to have a discussion in the wider debate about what an ideal dairy sector would look like in
721 the context of biosecurity – what is a “biosecurogenic” dairy farm? The dairy sector is
722 currently mostly characterised by open, fluid farm systems, but is compared unfavourably
723 with the superior biosecurity in the more closed, self-contained pig sector. These comparisons
724 with the pig sector surely require more thought, given the substantial and important
725 differences between the two sectors. And a discussion may need to focus on good biosecurity
726 within a multiplicity of dairy farm types, different imaginings of “biosecurogenic”
727 environments.

728 *Conflicting frames*

729 According to the vets in this study, and in other literature, vets and farmers may take a
730 different view of how effective biosecurity can be within the physical constraints on the farm.
731 The vets in this study stated that farmers do not always take responsibility for biosecurity and
732 there is no “blame culture” in the dairy farming sector over disease. Here farmers can be seen
733 to be framing biosecurity barriers as existing at a contextual scale – biosecurity is an issue
734 related to the open nature of dairy systems which the farmer inherently has little control over.

735 Because biosecurity was not seen by farmers as entirely controllable, vets often stated that
736 farmers had a higher tolerance for disease status on their farm than the vet would prefer: they
737 may be aware that they have a disease issue on their farm but they may still resist treating it
738 as the vet advocates. According to the vet some farmers may see some level of disease
739 problems as a normal part of dairy farming. The vet sees the farmer as operating with their
740 own meaning of “good enough, not broke” biosecurity.

741 Within the interpersonal vet-farmer relationship the vet tries to convince the farmer that a
742 disease problem means that something *is* broken and needs fixing and that it is possible to fix
743 it. They try to reframe the issue to the individual or interpersonal scale. This is also the frame
744 that is promoted by government and others (Defra et al., 2004): biosecurity is poor but the
745 farmer and vet acting together can have an impact on biosecurity. According to vets, the
746 farmer is resisting both of these messages. The farmer may not have the power to convince
747 the government or vets of their framing of the issue: that biosecurity is adequate for their
748 current purposes or in any case difficult to influence given their current situation, but they do
749 have the power not to pay for the vet’s disease prevention services or take the vet’s advice,
750 and to ignore the messages from government. Thus vets express frustration that their message
751 about better biosecurity is not being listened to and they do not see the farmer enough.

752 This analysis focused on the role of vets, and their perception of farmers’ role, and did not
753 touch on the role of industry and government in biosecurity, which present further ways of
754 considering biosecurity. These could be important given the public goods nature of
755 biosecurity benefits (Sibley, 2010). Another limitation of the study is that qualitative methods
756 do not provide information on the prevalence of views among a particular group but rather
757 aim to explore the meanings around a topic in depth. In addition frame analysis does not tell

758 us whether vets' views on biosecurity are correct or incorrect, but rather it gives us
759 information about the different ways in which vets view the situation.

760 **Conclusion**

761 We can take three important points from this discussion. Firstly, biosecurity barriers, often
762 the same barriers, were framed by vets in different ways that define the problem differently
763 and offer different solutions. Biosecurity can be tackled at the scale of farmers' individual
764 barriers, vets' individual barriers; the interpersonal relationship between farmers and vets;
765 and at the scale of the social and physical context they operate within. Vets' influence was
766 mostly seen to be at the individual and interpersonal level, they had little perceived control
767 over the context they and farmers operated within. But even at the individual/interpersonal
768 levels vets felt they were struggling to make the impact they would like to.

769 Secondly, vets framed themselves and farmers at times as idiosyncratic groups of individuals
770 that lacked cohesion. For farmers this was seen to be because their attitudes could be very
771 different and they all had a different physical context on their farm. Vets expressed
772 exasperation about the diversity of views and situations, but also framed themselves as well
773 placed to work with individual farmers and build up a relationship over time. Heterogeneity
774 among vets was viewed as good or necessary to the extent that vets face different
775 circumstances and will need to tailor advice to each farmer, but in a negative light to the
776 extent that it inhibited the spreading of best practice and painted the veterinary profession as
777 lacking consistency.

778 And thirdly, vets' role in education and advice giving was seen to be not only about
779 information but communicating their perspective and values on biosecurity to farmers. In
780 order to increase their relevance to on-farm biosecurity, vets may be operating with the
781 individual and interpersonal frames of biosecurity: disease control is possible and worthwhile

782 through a good interpersonal relationship between farmer and vet, and the farmer taking
783 individual responsibility for biosecurity measures. The farmer, according to the vets in this
784 and other studies, may be emphasizing the *contextual* frame of biosecurity that sees barriers
785 as operating at the sectoral, geographical and logistical level. They downplay the individual
786 frame and their control on biosecurity. Both frames are legitimate in some sense, but it means
787 that vets and farmers may be talking past each other through using these different frames.
788 Thus the analysis suggests a need to step back in the wider debate and within the vet-farmer
789 interaction and ask “barriers to what?” – how could shared goals and understanding around
790 what “good biosecurity” means be created? Many suggest that joint decision making between
791 farmer and vet is needed, and that an important and often missing step on biosecurity is the
792 process of vets listening to farmers and the setting of mutual goals (Atkinson, 2010). Within
793 the wider debate we could ask what “good biosecurity” should look like in a future dairy
794 sector? More research and discussion is needed on these questions if barriers are to be
795 tackled.

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799 comments on the paper.

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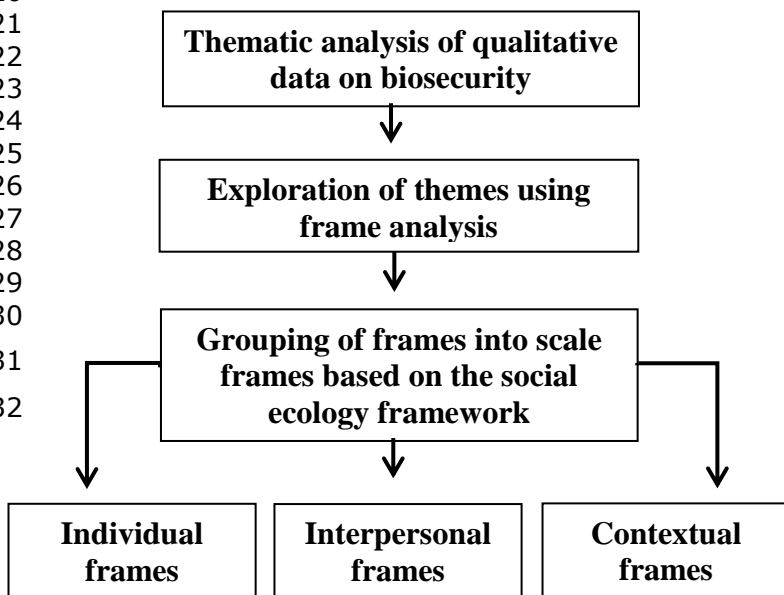
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1019 Figure 1 Framework for analysis and interpretation of data

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1033 Table 1. Vet respondents' framing of farmer and vet barriers to implementing better
 1034 biosecurity in the dairy sector.

Scale frame:			
Individual barriers	Interpersonal barriers	Contextual barriers	
		Social context	Physical context
<p>Financial: farmer not prioritising biosecurity – making false economies.</p>	<p>Differing values and perspectives: farmer does not problematize disease on the farm. Farmer does not take control of it.</p> <p>Vet sees disease problems as more “problematic” than farmer. Wants farmer to take control of them.</p>	<p>Time: farmers do not have enough time to implement biosecurity measures.</p> <p>Vets do not have enough time to adequately deal with biosecurity.</p>	<p>Logistical: Farmers do not have adequate facilities and infrastructure for biosecurity.</p> <p>Logistical: Dairy farms are open systems – hard to regulate flows of disease.</p>
<p>Time: farmer not prioritising biosecurity – not taking the time.</p> <p>Vet not prioritising biosecurity – not taking the time.</p>	<p>Role of the vet on the farm: Farmer does not make adequate use of vet’s services. Vet wants to see farmer more regularly.</p> <p>Farmer wedded to “test and treat” model of veterinary intervention rather than “predict and prevent” model</p> <p>Vet wedded to “test and treat” model of veterinary intervention rather than “predict and prevent” model.</p>	<p>Financial: farmer does not have the money to invest/spend on biosecurity – linked to milk prices</p> <p>Market failure – not enough market reward for good biosecurity.</p>	
<p>Farmer knowledge: some farmers do not have enough knowledge on biosecurity.</p> <p>Some farmers <i>do</i> have enough knowledge but are not motivated to implement it.</p>	<p>Communication Vets does not communicate enough and well with farmers.</p>	<p>Lack of biosecurity culture: collective mentality among farmers does not recognise the value of biosecurity</p>	

Vet knowledge and cohesion: Some vets are not well enough informed on biosecurity. Vets are also not working together adequately to share knowledge.			
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Authors and year	Title	Theoretical framework	What was studied
Garforth et al. 2006	Farmers' attitudes towards techniques for improving oestrus detection in dairy herds in South West England	Theory of Reasoned Action	Attitudes (outcome belief and outcome evaluation); and subjective norms (subjective belief and motivation to comply).
Heffernan et al. 2008	An exploration of the drivers to biosecurity collective action among a sample of UK cattle and sheep farmers	A socio-psychological approach. Attitudes are made up of cognitive and affective factors. Attitudes and contextual factors drive behaviour	Attitudes toward individual vs. group behaviour; attitudes towards existing biosecurity regulations; and perceptions of threats/emotive factors.
Gunn et al. 2008	Measuring and comparing constraints to improved biosecurity amongst GB farmers, veterinarians and the auxiliary industries	Framework based on Theory of Reasoned Action	Attitudes (outcome perception and importance of outcome); and subjective norms (referents and importance of referents).
Jansen et al. (2009)	Explaining mastitis incidence in Dutch dairy farming: The influence of farmers' attitudes and behaviour	Developed own framework, drawing on Theory of Planned Behaviour (TPB).	Attitudes towards mastitis and mastitis control.
Palmer et al. 2009	Farmers, animal disease reporting and the effects of trust: A study of western Australian sheep and cattle farmers	Developed own framework drawing on the Edinburgh Study of Decision Making on Farms, Theory of Planned Behaviour, Theory of Reasoned Action and Health Belief Model, as well as relevant literature.	Biosecurity practices; sociodemographic factors; situational factors; attitudes; perceived risk and trust; perceived control; information gathering.
Ellis-Iversen et	Perceptions, circumstances and	Social ecology model using Theory of	TPB – Attitudes; normative beliefs; and beliefs in self

al. 2010	motivators that influence implementation of zoonotic control programs on cattle farms	Planned Behaviour and extrinsic factors	efficacy; and extrinsic circumstances – community and industry; culture and society; and knowledge, skills and ability.
Valveeva et al. 2011	Perceived risk and strategy efficacy as motivators of risk management strategy adoption to prevent animal diseases in pig farming	Framework based on health belief model (HBM)	HBM – Perceived susceptibility to disease occurrence; perceived benefits of action; and perceived severity of disease impact. Additional factors – cues to action (past experience with animal disease); internal risk exposure; risk attitude; and self-protection behaviour.
Alarcon et al. 2013	Pig farmers' perceptions, attitudes, influences and management of information in the decision-making process for disease control	Theory of planned behaviour	TPB – Attitudes (outcome belief and outcome evaluation); subjective norms (subjective belief and motivation to comply); and perceived behavioural control (control belief/self efficacy and power of control).
Garforth et al. 2013	Farmers' attitudes to disease risk management in England: A comparative analysis of sheep and pig farmers	Developed own framework from TPB and TRA and literature on animal health	Exposure to sources of information; attitude to animal disease risk; previous experience; knowledge/awareness of practices; attitude to practices; social influences; inertia/habit; perceived farm constraints; and perceived ability it implement practice.

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