

**Sheep farmers' attitudes to farm inspections and the role of sanctions and rewards  
as motivation to reduce the prevalence of lameness**

**Running title** Rewards and sanctions to reduce sheep lameness

Nicola LBH Liu<sup>†</sup>, Jasmeet Kaler<sup>§</sup>, Eamonn Ferguson<sup>‡</sup>, Holly O'Kane<sup>†</sup>, Laura E Green<sup>\*†</sup>

<sup>†</sup>School of Life Sciences, University of Warwick, Gibbet Hill Road, Coventry CV4 7AL, UK

<sup>‡</sup>School of Psychology, University of Nottingham, University Park, Nottingham NG7 2RD,  
UK

<sup>§</sup>School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington  
Campus, Sutton Bonington, Leicestershire LE12 5RD, UK

\*corresponding author: Nicola LBH Liu

[N.L.B.H.Liu@warwick.ac.uk](mailto:N.L.B.H.Liu@warwick.ac.uk)

Tel: +44 (0)24 7652 3797

Fax: +44 (0)24 7652 2052

## 1 **Abstract**

2 The Welfare of Farmed Animals (England) Regulations 2007 make it an offence to allow  
3 unnecessary suffering to animals, highlighting that farmers have a duty of care for their  
4 animals. Despite this, the current global mean prevalence of lameness in sheep in England is  
5 5%; i.e. ~750,000 lame adult sheep at any time. To investigate farmers' attitudes to sanctions  
6 and rewards as drivers to reduce the prevalence of lameness in sheep, farmers' attitudes to  
7 external inspections, acceptable prevalence of lameness and attitudes on outcomes from  
8 inspections were investigated using a self-administered questionnaire. A total of 43/102  
9 convenience-selected English sheep farmers responded to the questionnaire. Their median  
10 flock size was 500 ewes with a geometric mean prevalence of lameness of 2.8%. Few farmers  
11 selected correct descriptions of the legislation for treatment and transport of lame sheep.  
12 Participants considered 5–7.5% prevalence of lameness acceptable and were least tolerant of  
13 farmers who rarely treated lameness and most tolerant of farmers experiencing an incident  
14 out of their control, e.g. disease outbreak. Participants consider sanctions and rewards would  
15 help to control lameness on sheep farms in England. Sanctions (prosecution, reduction in  
16 payment from the single (basic) payment scheme or suspension from a farm assurance  
17 scheme) were considered “fair” when lameness was  $\geq 10\%$  and rewards “fair” when lameness  
18 was  $\leq 2\%$ . If these farmers' attitudes are applied to 1,300 randomly selected flocks with a  
19 mean prevalence of lameness of 3.5%, 24.6% flocks had  $\geq 10\%$  lameness and would be  
20 sanctioned and 32.5% flocks had  $\leq 2\%$  lameness and would be rewarded.

21 **Keywords:** lameness, rewards, sanctions, attitudes, legislation, animal welfare

## 22 1. Introduction

23 The control of lameness is covered by legislation and codes of practice on the welfare of  
24 livestock. The Welfare of Farmed Animals (England) Regulations 2007 came into force on 1<sup>st</sup>  
25 October 2007 under the Animal Welfare Act of 2006. The Act sets down minimum standards  
26 for the protection of all farmed livestock, making it an offence to cause or allow unnecessary  
27 suffering to any animal. This, therefore introduced a duty of care for all animals, setting out  
28 minimum standards for accommodation, feeding and watering, maintenance of equipment  
29 used with livestock, and regularity of inspection. This is to ensure that animals are in a state  
30 of good well-being. The Welfare of Farmed Animals (England) Regulation 4 (2)(d) requires  
31 that a person responsible for a farmed animal “must have regard to its physiological and  
32 ethological needs in accordance with good practice and scientific knowledge.” Sheep farmers  
33 must also comply with the Council Regulation (EC) No 1/2005 on the protection of animals  
34 during transport and related operations. In addition, the Welfare of Animals (Transport)  
35 (England) Order 2006 bans the transport of unfit animals, including those that are injured or  
36 present physiological weaknesses or pathological processes, and those unable to move  
37 independently without pain. The legislation is written to cover all farmed animals or all  
38 animals, respectively, so the wording is generic and the style of language is complex.

39 Other than legislation, codes on welfare are available that are species specific, these provide  
40 guidance on how to care for animals and how to comply with the Act and any regulations  
41 issued under the Act. Breaching a code, in itself, is not an offence but could be used by a  
42 court to establish or negate liability. Approximately 1% of sheep farms in Great Britain (GB)  
43 are inspected annually by the Animal and Plant Health Agency (APHA) to investigate  
44 compliance with welfare legislation and code (KilBride *et al* 2012; Clark *et al* 2016).

45 In addition to the above, there are statutory management requirements (SMRs) which farmers  
46 must comply with under cross compliance with the EU to qualify for full payment under the  
47 direct payments schemes. These offer a layer of income support to farmers as well as  
48 targeting specific types of beneficiaries funded in the EU; there are a number of specified  
49 SMRs to which sheep farmers must adhere. Of particular importance is SMR 13 (previously  
50 SMR 18) (Defra, 2015) which requires farmers to thoroughly inspect their livestock as often  
51 as necessary to avoid suffering, and to ensure that they are looked after by staff who have the  
52 correct skills and knowledge. Approximately 1% of claimant farms in GB are inspected  
53 annually to investigate compliance with SMRs (Clark *et al* 2016).

54 Farm assurance schemes were developed to ensure that producers comply with certain  
55 standards of food safety and animal welfare in the UK as a result of well-publicised food  
56 scares during the 1980s and 1990s (Knowles *et al* 2007), which led to increased pressure on  
57 the agricultural industry to improve its practices, and the Food Safety Act of 1990. Different  
58 quality assurance schemes (QAS) weight standards differently (Wood *et al* 1998; Morris &  
59 Young 2000), for example, the Freedom Food scheme set up by RSPCA in 1994 emphasises  
60 animal welfare (RSPCA 2013a). Other schemes such as Red Tractor are overseen by Assured  
61 Food Standards (AFS) and carry out independent inspections to confirm businesses are  
62 meeting standards on food safety, animal welfare and the environment. In contrast to 1% of  
63 farms inspected, all farms that are members of these voluntary, private schemes are inspected  
64 at 12 – 24 month intervals (Clark *et al* 2016).

65 Despite legislation, regulation, codes of practice and inspections for all aspects of animal  
66 welfare, lameness in sheep is endemic in GB where most sheep farms in England have some  
67 lame sheep. To comply with legislation, where every animal's welfare is of concern and Farm  
68 Animal Welfare Committee (FAWC 2011) ideal, all lame sheep would be treated and in

69 recovery. Lameness in sheep is a significant welfare concern for farmers and vets (Goddard  
70 *et al* 2006; FAWC 2011). Lamé sheep are in pain and, if left untreated, develop hyperalgesia  
71 (Ley *et al* 1989; FitzPatrick *et al* 2006), lose body condition and are less productive (Wassink  
72 *et al* 2010). Many sheep farmers do not treat individual sheep the day they become lame  
73 (Kaler & Green 2008a) and interpretation of the legislation is unclear, however, ‘intention to  
74 treat’, e.g. if a farmer demonstrates a routine of treating sheep within three days of becoming  
75 lame, this fits with the evidence for best practice (Wassink *et al* 2010).

76 Sheep farmers are able to estimate the prevalence of lameness in their flock reliably (King &  
77 Green 2011); with >90% farmers considering sheep lame with locomotion score 2 or above  
78 (Kaler *et al* 2009). In 2004, 10.4% of English flocks were lame at any one time (Kaler &  
79 Green 2008b). In 2011, the FAWC published a recommendation that ‘the prevalence of  
80 lameness in flocks farmed in Great Britain should be reduced to 5% or less by 2016 as an  
81 interim target, and to 2% or less, (which is already possible with best practice (Wassink *et al*  
82 2010)) by 2021’ (FAWC 2011). There is a wealth of evidence that avoiding routine foot  
83 trimming (Wassink *et al* 2003; Kaler & Green 2009; Winter *et al* 2015) and early and  
84 accurate diagnosis of the cause of lameness, followed by the correct treatment leads to rapid  
85 recovery (Kaler & Green 2008a; Kaler *et al* 2010; Dickins *et al* 2016) that reduces the  
86 prevalence of lameness (Wassink *et al* 2010), prevents loss of body condition, and so reduces  
87 unnecessary suffering; summarised in (Green *et al* 2012).

88 In 2013, 1,300/4,000 English sheep farmers responded to a questionnaire, selected through  
89 stratified random sampling of flocks with > 200 ewes. From this, the global mean prevalence  
90 of lameness had fallen from 10.4% to 5% (Winter *et al* 2015). The geometric mean flock  
91 prevalence of lameness was 3.5% and, again, a lower prevalence of lameness within  
92 respondents was associated with rapid and correct treatment of lame sheep and avoiding foot

93 trimming (Winter *et al* 2015). These practices are defined as ‘current best practice’ (O’Kane  
94 *et al* 2016) to minimise lameness in sheep.

95 A reduction in national average lameness to 5% is an improvement from 10.4% of 2004 and,  
96 whilst on target for FAWC’s 2016 target, it is still higher than the proposed target of 2% by  
97 2021. It is possible that a further reduction in the prevalence of lameness might be possible  
98 through legislation. Enforceable legislation from a central authority is known to be a  
99 powerful mechanism to encourage compliance and cooperation (Gurerk *et al* 2006; Traulsen  
100 *et al* 2012) even if that sanction is not always applied.

101 There are insufficient resources to apply legislation across all farms in England and farmers  
102 view the current systems of inspection as ‘unfair’ if they are caught in breach of legislation.  
103 Because inspecting farms is resource intensive, Government would prefer farmers to self-  
104 regulate (Defra 2014). It is possible that self-regulation could be done by farm assurance  
105 schemes with sanctions for high percentages of lame sheep or rewards for low percentages of  
106 lame sheep or both. There is also a large literature showing that people cooperate when they  
107 can be sanctioned by peers (Traulsen *et al* 2012), however, rewarding good practice also  
108 results in compliance (Balliet *et al* 2011).

109 In this paper, we investigate the role of all external inspections for compliance with  
110 legislation, codes of practice and private schemes as well as farmers’ attitudes about rewards  
111 and sanctions as motivators to control lameness in their flock and in the national sheep  
112 industry in order to evaluate whether, and how, external inspections might be used to further  
113 reduce the prevalence of lameness in sheep. Questions of interest are when do farmers think  
114 that sanctions or rewards should be used? Do farmers view these options as fair and viable?  
115 Two key concepts with respect to fairness and viability are (1) acceptable risk (Fischhoff *et al*  
116 1978; Freeman & Bass 1992; Dowling & Staelin 1994) and (2) legitimisation. One aspect of

117 acceptable risk refers to the level of risk people are willing to tolerate or indulge (Dowling &  
118 Staelin 1994). In the context of lameness, this would equate to the prevalence of lameness in  
119 a flock that farmers consider the acceptable upper limit. Legitimization here refers to  
120 legitimizing the behaviour due to external factors (Lotem *et al* 1999). For example, if sheep  
121 are lame due to no fault of the farmer, then this should mitigate against sanctions (Ferguson  
122 *et al* 2012). It should only be fair and viable to sanction a farmer whose prevalence of  
123 lameness exceeds the acceptable upper limit when there are no legitimate means to mitigate  
124 against the sanction. We used these basic ideas to develop the scenarios explained below.

## 125 **2. Materials and Methods**

126 Ethical approval for the study was granted by the University of Warwick human ethical  
127 review committee, BRSEC. Throughout the paper, participant is used to refer to a farmer who  
128 responded to this questionnaire, whilst farmer is the general grouping of sheep farmers in  
129 England.

### 130 ***2.1 Questionnaire design and administration***

131 Consensus methods were used to derive coteries of risk; these have been used commonly  
132 elsewhere e.g. linked to health and climate change (Johnson 2003; Blaser & Cornuz 2015).  
133 Experts in lameness in sheep, the sheep industry, legislation and code and health psychology  
134 from the Universities of Warwick and Nottingham designed a 12-page questionnaire to  
135 capture data from participants on their membership of farm assurance and organic  
136 certification schemes (Table 1), their management and treatment of lameness, the period  
137 prevalence of lameness between July 2013 and June 2014, personal and flock descriptors and  
138 external inspections of their farms between January 2011 and December 2014 (Table 2).

139 One section of the questionnaire was designed to investigate knowledge of legislation in  
140 England regarding lameness in sheep. In this section, participants were asked to select one  
141 statement which best described their understanding of the current law relating to the care of  
142 lame sheep on English farms and the transport of lame sheep in England. Participants were  
143 then asked to rate their confidence in their selected statement, presented in Table 3. Another  
144 section requested participants' attitudes to external inspections of their flock and were asked  
145 to respond to four statements using a 5-point Likert scale ranging from 'strongly disagree' to  
146 'strongly agree'. Statements included "there is currently too much external inspection of  
147 animals in my flock" and "external inspections to check animal welfare in my flock waste my  
148 time" (Table 4).

149 To investigate attitudes of theoretical inspections specifically for lameness, four cut-off  
150 percentages of lameness were defined: 2% (FAWC recommended target prevalence  
151 achievable with current evidence (FAWC 2011), 5% (current global mean prevalence (Winter  
152 *et al* 2015), 10% (global mean prevalence of lameness in 2004) and 25% (above the 75<sup>th</sup>  
153 percentile of prevalence of lameness (Winter *et al* 2015). Participants were asked which  
154 prevalence of lameness they perceived to be the upper acceptable limit (Theme 1) and at what  
155 prevalence of lameness it was fair to sanction farmers (Theme 2) in the four scenarios (A –  
156 D) following an inspection by an outside body: A) a farmer who rarely treats lame sheep; B)  
157 a farmer who has managed lame sheep the same way for over 20 years; C) a farmer who uses  
158 best practice (O'Kane *et al* 2016) to manage lameness and D) where the prevalence of  
159 lameness has increased rapidly in the past few months despite seeking and following  
160 veterinarian's advice. In theme 1, participants were asked to select a fair prevalence of  
161 lameness for each scenario. In theme 2, participants were asked to select by prevalence of  
162 lameness, and scenarios A – D, what they considered the fairest outcome from the inspection.  
163 The possible outcomes were prosecution, reduction in single payment (the EU subsidy



164 payment to sheep farms), suspension of farm assurance status, no action, able to sell stock to  
165 specialist suppliers, gain a bonus on single payment and extra payment per kilo of lamb sold.  
166 Results from Theme 1 indicates farmers' acceptable risk and Theme 2, the legitimised  
167 prevalence of lameness above which it would be fair to intervene: if farmers are sensitive to  
168 mitigating circumstances then they should select a higher acceptable prevalence of lameness  
169 before it is fair to sanction when there is a legitimization for the lameness prevalence than  
170 where there is not.

171 In theme 3, three situations were presented to investigate the attitudes of participants on  
172 sanctions and rewards following an inspection. The situations were 1) a law is introduced that  
173 sets a legal cut-off for the maximum prevalence of lameness, farmers with prevalence above  
174 this maximum level would be breaking the law, every flock is inspected every year to check  
175 for compliance; 2) a penalty is introduced so that if lameness is above a maximum level when  
176 inspected by the Rural Payments Agency, rural payment income would be reduced and 3) if  
177 farmers were able to maintain lameness in their flock below a certain prevalence, they were  
178 able to sell under a new 'Assured Sound Sheep' trademark. This gives an extra payment per  
179 kilo of lamb sold. For each situation, farmers selected the maximum upper prevalence of  
180 lameness and whether the proposed situation would be an effective way to reduce the  
181 prevalence of lameness on sheep farms in England and whether it would impact their  
182 business negatively or positively. Theme 3 assessed farmers' attitudes on the effectiveness of  
183 rewards and sanctions in particular contexts to differentiate fair from effective.

184 Most questions were closed or semi-closed and some questions had an "other" option  
185 allowing for free text. The questionnaire was read and commented on by all members of  
186 research groups at both Universities. Finally, the questionnaire was pilot tested on 5 sheep  
187 farmers in England (equivalent to 5% of the target sample) to estimate a realistic time frame  
188 for the completion of the questionnaire and to check farmers' understanding of the

189 questionnaire using a feedback form; two farmers responded. They completed the  
190 questionnaire correctly and indicated that the questionnaire was logical and they understood  
191 the questions; no changes were therefore made.

## 192 ***2.2 Recruitment of participants***

193 In 2011, 449/972 sheep farmers selected using stratified random sampling based on county  
194 and flock size from 18,000 members of the AHDB Better Returns programme participated in  
195 a University of Warwick study (King 2013; Brian, personal communication 2016). The mean  
196 global period prevalence of lameness was 5.6%. A total of 102/449 farmers (global mean  
197 period prevalence of lameness of 4%) had agreed to participate in further research and this  
198 convenience-selected group were invited to take part in the current study. Questionnaire  
199 packs containing a cover letter, the questionnaire and a prepaid return envelope were sent to  
200 farmers in December 2014. Reminder letters were sent in January 2015, and a second  
201 questionnaire pack was sent to those who had not returned the questionnaire by February  
202 2015. Thank-you letters were sent on return of questionnaires. Each questionnaire returned  
203 was allocated a unique number and sent to an external agency (Wyman Dillon Ltd) for  
204 double data entry. The data received back were stored in Microsoft Excel, cleaned manually  
205 and checked for consistency with the raw data. Where answers were illogical / inconsistent  
206 they were excluded from statistical analyses.

## 207 ***2.3 Statistical analysis***

208 Summary statistics of central tendency and dispersion were made for each variable in  
209 Stata/SE 13.1 (StataCorp.2013). The geometric mean (GM) lameness and 95% confidence  
210 intervals (CI) and the median and range of flock sizes were estimated. Graphs were made to  
211 summarise data on the acceptable prevalence of lameness by plotting scenarios by 2%, 5%,  
212 10% and 25% lameness and whether participants ranked this as acceptable or unacceptable.

213 Responses from participants on cut-off levels for sanctions and rewards were compared with  
214 the distribution of lameness reported in a 2013 survey of 1,300 randomly selected sheep  
215 farmers in England (Winter *et al* 2015) to estimate the percentage of farmers in each category  
216 that would be sanctioned and rewarded.

### 217 **3. Results**

218 A total of 43/102 (42%) farmers returned the questionnaire; however, not all farmers  
219 answered all questions. There were 40 male and 1 female respondents. Two participants were  
220 26-35 years old, 11 were 36-45, 13 were 46-55, 10 were 56-65 and 5 were > 65 years old.  
221 The flock size ranged from 28 to 1,400 ewes (median 500). Seventy-two percent of  
222 participants were members of the Red Tractor scheme (Table 1); 98% claimed rural payments  
223 subsidy; 5 were members of a retailer scheme but no one was a member of a selling group.  
224 Between January 2011 and December 2014, 33 participants' farms were inspected, most for  
225 farm assurance. The number of external inspections per farm ranged from 1 to 9 (Table 2).

#### 226 ***3.1 Prevalence of lameness and management of ewes with footrot, July 2013 - June 2014***

227 The GM prevalence of lameness from July 2013 to June 2014 was 2.8% (95% CI 2.3% –  
228 3.5%); this was lower than the GM of 3.5% (CI 3.3% – 3.7%) of a random sample of 1,300  
229 farmers in 2013 (Winter *et al* 2015). Overall 39%, 90%, 98% of participants had a prevalence  
230 of lameness  $\leq 2\%$ ,  $\leq 5\%$  and  $\leq 10\%$  respectively; 1 respondent had a prevalence of 12%.  
231 Approximately 61% treated lame ewes within three days, 56% always, 37% sometimes and  
232 7% rarely used antibiotic injections to treat ewes lame with footrot and 29% never or rarely  
233 trimmed the feet of lame ewes. In addition, 63% culled ewes because they had been lame,  
234 35% culled after the second lameness event and 31% culled ewes after they had been lame

235 more than twice. There were 28%, 60%, 28% and 40% of farmers routinely foot trimming,  
236 routinely foot bathing, vaccinating and separating lame sheep respectively. Overall,  
237 participants were more compliant, but not completely, with best practice for both treatment  
238 and control of lameness than the 2013 respondents (Winter *et al* 2015).

### 239 ***3.2 Understanding of the legislation in England relating to lameness in sheep***

240 Forty-two percent of participants did not think there were any laws relating to the treatment  
241 of lame sheep on a farm, whereas 35% answered correctly that it is ‘illegal to have untreated  
242 lame sheep on a farm without evidence of intention to treat’; 18% of those who selected the  
243 correct statement were very confident, 73% were fairly confident and 9% were not confident  
244 with their answer (Table 3).

245 When asked about the law regarding transport of lame sheep in England, 56% of farmers  
246 selected the correct statement that ‘it is illegal to transport sheep that are unable to move  
247 independently without pain or walk unassisted to any destination’; 50% were very confident  
248 of their answer, 39% were fairly confident and 11% were not confident. However, 34% of  
249 participants thought that it was ‘illegal to transport sheep that are unable to move  
250 independently without pain or walk unassisted unless going straight to slaughter’ (Table 3).

#### 251 ***3.2.1 Attitudes on external inspections for lameness***

252 The frequency of inspections reported by participants was similar to that from a recent survey  
253 of 771 farmers in GB (NFU 2015). Of the 38 participants that responded, 16% would not  
254 welcome inspection of their flock to check compliance with animal welfare legislation and  
255 37% felt that external inspections to check animal welfare ‘wastes time’. In addition, of 39  
256 participants that responded, 41% thought that external inspections were not important in

257 maintaining animal welfare standards. When asked whether they thought there was too much  
258 external inspection 64% were impartial, 23% disagreed and 13% agreed (Table 4).

### 259 *3.2.2 Themes 1 and 2. Attitudes on fair outcomes of external inspections for lameness*

260 In Theme 1, (Figure 1), participants identified 7 - 7.5% as the upper acceptable prevalence of  
261 lameness for 3 of the 4 scenarios (B-D), but 5% for the scenario 'the farmer rarely treats lame  
262 sheep' (A). Participants' responses to a fair outcome from inspection in Theme 2 (Figure 2)  
263 show a number of interesting features. First, suspension of farm assurance membership, a  
264 voluntary based sanction is preferred (Gurerk *et al* 2006) over prosecution. Secondly, the  
265 prevalence of lameness, where suspending farm assurance membership is seen to be a fair  
266 sanction, varies as a function of scenario. When the farmer rarely treats (A) or uses the same  
267 method to manage lameness (B), prosecution is viewed as a fair option at 8-10% lameness,  
268 however, when the farmer uses best practice (C) or there is a sudden increase despite seeking  
269 advice (D), this increases substantially to approximately 22% and 17%, respectively.  
270 Rewards were rarely selected over sanctions. Most participants selected no reward for flocks  
271 even with  $\leq 2\%$  lameness: only 6 participants in total selected rewards; a bonus in rural  
272 payment ( $n = 2$ ), able to sell to specialist suppliers ( $n = 2$ ) or extra payments per kg lamb sold  
273 ( $n = 2$ ).

### 274 *3.2.3 Theme 3. Attitudes on rewards and sanctions for lameness*

275 Participants identified  $\leq 10\%$  as the threshold for a fair legal cut-off prevalence of lameness  
276 (Figure 3A) and  $>10\%$  when farmers should be penalised (B). They considered that this  
277 would lead to a reduction in prevalence of lameness nationally and it would benefit on their  
278 own farm. Most participants considered a legal cut-off  $<10\%$  would negatively affect their  
279 farm business (A). Participants were increasingly less likely to consider that farmers should  
280 be rewarded as the prevalence of lameness increased from 2% to 25% (C). Participants

281 reported that rewards up to 5% prevalence of lameness would impact positively on their farm  
282 business, but that rewards up to a maximum of 2% prevalence of lameness would impact  
283 negatively on their business (C).

284 If the same cut-offs for sanctions and rewards identified by the farmers in the current study  
285 were applied to the distribution of lameness in the 2013 study of 1,300 randomly selected  
286 lowland sheep farmers in England (Winter *et al* 2015), approximately 32.5% of flocks had  
287  $\leq 2\%$  lameness and would be rewarded and approximately 24.6% of flocks had  $\geq 10\%$   
288 lameness and so would be sanctioned.

#### 289 **4. Discussion**

290 To the authors' knowledge, this is the first study to investigate sheep farmers' attitudes to  
291 sanctions and rewards as incentives to control the prevalence of lameness in their own flock  
292 and nationally. The participants were convenience-selected because it provided a willing  
293 group of respondents, a historic baseline prevalence of lameness and ensured that these  
294 farmers were not in another on-going study of lameness (Winter *et al* 2015). The number of  
295 participants was relatively small. Participants had a geometric mean prevalence of lameness  
296 in their flock of 2.8%; this is lower than the 3.7% estimate from a random sample of English  
297 farmers (Winter *et al* 2015). As would therefore be expected, a greater proportion of  
298 participants were using 'best practice' than those in Winter *et al* (2015) when analysing their  
299 management strategies, and so we are reasonably confident that whilst we did not define 'best  
300 practice' explicitly nor set it as a criterion, the respondents were aware of the principles of  
301 best practice to manage lameness in sheep. As the mean prevalence of lameness was lower  
302 than for a random sample, it is possible that the cut-offs for acceptable prevalence of  
303 lameness in themes 1 and 2, and rewards and sanctions in themes 2 and 3 might be slightly  
304 biased downwards. However, the very consistent pattern of responses that varied by context

305 suggests that participants believed that the national industry and they themselves would be  
306 influenced / affected by the theoretical situations proposed.

307 Participants differentiated an absolute upper limit to the prevalence of lameness that was  
308 acceptable (Theme 1), an upper limit that depended on scenario (where the farmer's inability  
309 to control lameness was identified by participants as a case for leniency) when sanctions  
310 could be applied (Theme 2) and participants rationally identified how different sanctions and  
311 rewards might affect the English sheep industry and themselves (Theme 3). These patterns,  
312 discussed below, shows regularities consistent with farmers using the available information to  
313 make decisions about sanctions and rewards.

314 In theme 1, participants differentiated farmer behaviour and acceptable risk or prevalence of  
315 lameness that is tolerated (Figure 1). The farmer who rarely treated lame sheep was given a  
316 lower acceptable level of lameness (5%) than the farmer actively trying to manage lameness  
317 (7-7.5%). Interestingly, participants did not distinguish greatly between the farmer using best  
318 practice and the farmer using traditional approaches to manage lameness and expected both  
319 types of farmers to control lameness equally well. The respondents might not have  
320 differentiated the two types of managements; it could be that they assume the two are the  
321 same or think that different managements would be effective on different farms.

322 From theme 2, we see that deviation from the normative acceptable level of 7.5% is needed  
323 before it is considered fair for sanctions to be introduced. However, the extent of that  
324 deviation depends on the context facing the farmer (Figure 2). If the farmer faces a rapid  
325 increase in lameness despite following advice from a veterinarian, then there is greater  
326 tolerance. The underlying decision making mechanism that may account for these patterns  
327 cannot be identified from these descriptive results. However, they are suggesting a mixture of  
328 rapid affective process (anxiety, gut feelings), slower judgements (cost-benefit analysis) as

329 well as morality and ethics. These are all known to influence judgements about risk, its  
330 acceptance and reaction to others' violations of best practice (Slovic 1987; Sjoberg 2000;  
331 Slovic & Peters 2006; Kahneman 2011). For example, consider the finding that participants  
332 have a higher acceptable risk (are more lenient) for those who are performing best practice;  
333 they were more likely to be performing best practice and so this may reflect a 'gut feeling'  
334 based on feelings of similarity and we know that people are more generous to those who are  
335 similar to themselves (Kahneman 2011). Thus, participants identify with best practice  
336 farmers and protect the future self. The sanctioning decisions are then anchored relative to the  
337 acceptable level of risk of lameness of 7.5% that participants identify for good farmers  
338 (Tversky & Kahneman 1974) and they are, intuitively, more lenient towards farmers  
339 managing lameness like themselves. In addition, participants were more lenient towards the  
340 farmer who could legitimate their negative outcome (Lotem *et al* 1999; Ferguson *et al* 2012),  
341 showing that once the acceptable threshold for the good farmer was crossed, then sanctions  
342 were proportional to the degree to which the farmer had some control over any outbreak.  
343 Pragmatically and anecdotally, these results reflect the concern farmers have that inspectors  
344 and legislation cannot differentiate a sudden high uncontrollable prevalence of lameness from  
345 on-going high prevalence of lameness for a fair outcome of inspections (LE Green, personal  
346 communications since 2004).

347 The critical prevalence, selected by participants, for acceptable prevalence of lameness and  
348 cut-offs for sanctions and rewards were generally protective of their own situation (Theme 3),  
349 with the exception that whilst rewards for lameness prevalence  $\leq 2\%$  was selected as fair and  
350 effective nationally, approximately 40% of participants said this would impact their own  
351 business negatively and considered a fair reward when lameness prevalence was  $\leq 5\%$  would  
352 benefit their business. This suggests that these farmers know that the prevalence of lameness  
353 in their flock exceeds 2%, at least on occasion.



354 Consistent with the literature, in theme 2, participants preferred to sanction negative  
355 outcomes rather than reward positive outcomes (Fehr & Gächter 2002), although prosecution  
356 as a sanction was rarely selected as a fair outcome. This may reflect the feeling that losses  
357 loom larger than gains and people believe that sanctions result in greater behaviour change  
358 (Kahneman & Tversky 1979). However, the evidence for the relative effectiveness of rewards  
359 (incentives) and sanctions is not fully understood nor clear and to some extent, is dependent  
360 on the nature of the behaviour that is trying to be changed, and the person who is trying to  
361 change (Balliet *et al* 2011, Gneezy *et al* 2011, Ferguson & Starmer 2013, Boyce *et al* 2016).

362 Whilst legislation relates to every individual animal, the context of farming is that farmers  
363 work with populations of animals. This is challenging and makes interpretation of the law  
364 complex. According to the law, animals that are lame with no evidence of treatment can  
365 result in prosecution for failing to treat. However, a farm with some untreated lame animals,  
366 with evidence of an intention to treat, can be deemed acceptable. The cut-offs of prevalence  
367 of lameness >2% selected by most participants in the current study indicate that those farmers  
368 considered some untreated lame sheep acceptable. We did not investigate whether these  
369 would be in a planned programme of treatment.

370 Currently, the proportion of sheep farmers sanctioned for high prevalence of untreated  
371 lameness is not known. There were 63 RSPCA convictions under the Animal Welfare Act  
372 2006 for all farmed animals in 2013 (RSPCA 2013b). It is not possible to differentiate which  
373 of these were related to sheep, but it is clearly a very low number. With the cut-offs in the  
374 current study applied to respondents to Winter *et al* (2015), 24% of flocks would be  
375 financially sanctioned in our theoretical framework. This would increase sanctions above  
376 current activity hugely, but it would still be for prevalence of lameness of >10%, higher than  
377 might be expected if current legislation were fully enforced. If rewards were acceptable and

378 effective, as indicated by participants, then this might be a better approach and encourage  
379 farmers to reduce flock prevalence of lameness to <2%, the FAWC goal (FAWC 2011).

380 Four participants suggested that veterinary advice should be sought when the prevalence of  
381 lameness was high, whilst two participants highlighted the annual visit from their veterinarian  
382 as an external inspection. It is a legal requirement that veterinarians can only prescribe  
383 medicines to animals directly under their care. Some practice standards therefore include  
384 inspection of animals on farm at least once a year. One hypothesis to consider, given the  
385 desire by government for more private regulation, is that if all sheep flocks were inspected by  
386 their veterinarian each year, this could be a route by which new information on best practice  
387 for lameness, and other updates on managing health could be discussed with farmers, it  
388 would improve dialogue between farmers and veterinarians (Kaler & Green 2013; Bellet *et al*  
389 2015). One survey suggested that approximately 22% of sheep farmers have all-year-round  
390 contact with their veterinarians (ADAS 2008). If this could be increased, then these visits  
391 could be a one-to-one facilitated discussion and opportunity for new information to be given  
392 to farmers whatever the prevalence of lameness to lead to more rapid improvement in the  
393 management of lameness in sheep, assuming veterinary knowledge (Kaler & Green 2013).  
394 This could be audited by quality assurance schemes and together these activities might  
395 further decrease prevalence of lameness.

396 Participants' knowledge of current welfare legislation was poor with many farmers unable to  
397 identify the correct interpretation of legislation, and those who correctly identified the  
398 legislation indicated that they were not confident of their choice. It might be that the  
399 legislation, which is necessarily general to ensure it can be used appropriately, is confusing  
400 for farmers (and others in the livestock industry). This issue has been discussed recently in a

401 consultation by Defra (Defra 2011; Defra 2013) with the proposal to reform farm animal  
402 welfare codes so that they are moved from statutory codes to guidance drafted collaboratively  
403 with government, but led by the relevant sector of the livestock industry. The aim would be to  
404 'ensure that guidance on how keepers comply with farm animal welfare legislation is up to  
405 date, reflecting the latest scientific and veterinary knowledge whilst being presented in the  
406 most relevant way for farmers (Defra 2014). The current situation (2016) is that this has not  
407 been approved (Vet Record 2016). Whilst the participants had poor ability to identify the  
408 legislation on lameness, the average prevalence of lameness in their flocks was relatively  
409 low. This might indicate that knowledge of the law is unnecessary to manage lameness and  
410 that clearer explanation is not necessary. It could, however, be that if farmers were more  
411 aware of the legislation, that the stockperson should understand diseases in their flock, then  
412 all farmers would adopt best practice for management of lameness and every lame sheep  
413 would either be treated or scheduled for treatment within 3 days, then the prevalence of  
414 lameness would be <2% as in Wassink *et al* (2010).

## 415 **5. Animal welfare implications and conclusions**

416 As a study that investigated farmers' attitudes to including welfare measures within external  
417 inspection frameworks, these results might be used to evaluate whether, and how, external  
418 inspections could be used to reduce the prevalence of lameness in sheep and inform on the  
419 role of sanctions and rewards in welfare of sheep generally. It was observed that sanctioning  
420 (mainly to suspend farmers from their farm assurance membership) would be initiated above  
421 10% lameness, which could potentially encourage the 24% farmers with >10% lameness  
422 (Winter *et al* 2015) to reduce levels of lameness by introducing best practice. The flock  
423 prevalence of lameness is highly skewed and targeting flocks with the highest prevalence of

424 lameness would reduce the global mean prevalence of lameness in the national flock,  
425 currently at 5% to <4%. Rewarding low prevalence of lameness could encourage more than  
426 the current 33% of farmers to maintain a prevalence of lameness of <2%. In addition, the  
427 national prevalence of lameness might fall if all farmers followed the legislation that farmers  
428 are responsible to care for their livestock and use best practice.

#### 429 **Acknowledgements**

430 This research was funded by Defra as part of AW0512. The authors express their thanks to  
431 the farmers for completing the questionnaire. We would also like to thank Dr Annmarie  
432 Ruston for her input to the literature review.

433 Table 1 Number and percentage of 43 English sheep farmers by membership of voluntary  
 434 assurance schemes by the geometric mean (95% CI) average flock lameness between July  
 435 2013 and June 2014.

	N	%	GM (95% CI)
<b>Member of farm assurance or organic certification scheme</b>			
Yes	35	81.4	2.73 (2.10 – 3.54)
No	8	18.6	3.37 (2.23 – 5.10)
<b>Scheme</b>			
Red Tractor	31	72.1	2.68 (2.05 – 3.50)
Freedom Food	1	2.3	1.5*
Organic Certification	3	7.0	4.58 (0.49 – 43.20)
Other <sup>1</sup>	3	7.0	2.52 (0.93 – 6.81)
Did not answer	9	20.9	2.95 (1.84 – 4.73)
<b>Member of a supermarket supply group</b>			
Yes	5	11.6	2.19 (1.04 – 4.61)
No	38	88.4	2.95 (2.32 – 3.75)
If yes, specify <sup>2</sup>			
<b>Member of any other selling group</b>			
Yes	0	0	-
No	42	97.7	2.82 (2.25 – 3.53)
Did not answer	1	2.3	4*
<b>Claimant under basic payment scheme (BPS)</b>			
Yes	42	97.67	2.84 (2.27 – 3.56)
No	1	2.33	3*

436 <sup>1</sup>FABBL

437 <sup>2</sup>Four farmers are a member of Sainsbury's supermarket supply group and one farmer at  
 438 Waitrose

439 \*95% CI not calculated for small group sizes

440

441 Table 2 Number and percentage of 43 English sheep farmers by number of inspections per  
 442 year between January 2011 and December 2014, inspector and geometric mean (95% CI)  
 443 flock prevalence of lameness between July 2013 and June 2014.  
 444

<b>Sheep enterprise inspected between January 2011 and December 2014</b>	N	%	GM (95% CI)
Yes	33	76.74	2.83 (2.20 – 3.65)
No	8	18.60	2.47 (1.49 – 4.10)
Do not know	1	2.33	2*
Did not answer	1	2.33	12*
<b>Number of inspections January 2011 – December 2012</b>			
No inspections	14	32.6	-
Inspected once	21	48.8	-
Inspected twice	5	11.6	-
Inspected more than twice	3	7.0	-
<b>Number of inspections January 2012 – December 2013</b>			
No inspections	15	34.9	-
Inspected once	16	37.2	-
Inspected twice	9	20.9	-
Inspected more than twice	3	7.0	-
<b>Number of inspections January 2013 – December 2014</b>			
No inspections	15	34.9	2.95 (2.30 – 3.79)
Inspected once	17	39.5	2.84 (1.86 – 4.33)
Inspected twice	9	20.9	3.22 (1.68 – 6.14)
Inspected more than twice	2	4.7	1.26*
<b>Inspections Jan 2011 – Dec 2012 by</b>			
Animal Health/ APHA veterinarian	2	4.7	-
Local authority	2	4.7	-
Trading standards	6	14.0	-
Farm assurance	26	60.5	-
Other <sup>3</sup>	4	9.3	-
Did not answer	14	32.6	-
<b>Inspections Jan 2012 – Dec 2013 by</b>			
Animal Health/ APHA veterinarian	3	7.0	-
Local authority	1	2.3	-
Trading standards	11	25.6	-
Farm assurance	24	55.8	-
Other <sup>4</sup>	5	11.6	-
Did not answer	15	34.9	-
<b>Inspections Jan 2013 – Dec 2014 by</b>			
Animal Health/ APHA veterinarian	2	4.7	1.41*
Local authority	4	9.3	3.87 (1.15 – 13.04)
Trading standards	7	16.3	3.02 (1.27 – 7.21)
Farm assurance	27	62.8	2.69 (1.95 – 3.72)

Other <sup>5</sup>	2	4.7	1.79*
Did not answer	15	34.9	2.95 (2.30 – 3.79)

445 <sup>3</sup>One farmer was inspected by cross compliance for SFP, one farmer was inspected by ‘our  
446 veterinarian’, one farmer inspected by Organic and one other farmer by RPA during January  
447 2011 and December 2012.

448 <sup>4</sup>One farmer was inspected by cross compliance for SFP, two farmers inspected by  
449 private/our veterinarian, one farmer inspected by DEFRA, one farmer by Organic and the  
450 other farmer inspected by RPA during January 2012 and December 2013.

451 <sup>5</sup>One farmer inspected by ‘our veterinarian’ and the other farmer inspected by Organic during  
452 January 2013 and December 2014.

453 ‘-’ data not collected for these years

454 \*95% CI not calculated with small group sizes

455 Table 3 Number and percentage of participants' understanding of current law regarding care  
 456 and transport of lame sheep on English farms and confidence in selected statement  
 457

<b>Statements relating to the care of lame sheep on English farms (N = 31)</b>	Confidence in selected response		
	Very confident	Fairly confident	Not confident
It is illegal to have lame sheep on a farm	0	0	1
It is illegal to have untreated lame sheep on a farm	1	2	0
It is illegal to have untreated lame sheep on a farm without evidence of intention to treat	2	8 (19%)	1
There are no laws that relate to treatment of lame sheep on a farm	3	9 (21%)	1
Do not know or <a href="#">other</a> <sup>6</sup>	0	2	1
<b>Statements regarding transport of lame sheep on English farms (N = 32)</b>			
It is illegal to transport sheep that are unable to move independently without pain or walk unassisted to any destination	9 (21%)	7 (16%)	2
It is illegal to transport sheep that are unable to move independently without pain or walk unassisted unless going straight to slaughter	5 (12%)	3	3
There are no laws relating to transport of lame sheep on the farm	0	1	0
Do not know or other <sup>7,8</sup>	1	1	0

458 <sup>6</sup>One farmer specified that it is illegal to cause unnecessary pain and suffering

459 <sup>7</sup>One farmer specified that it is illegal to maltreat animals. This farmer was very confident in  
 460 their answer

461 <sup>8</sup>One farmer specified as point two (that it is illegal to transport sheep that are unable to move  
 462 independently without pain or to walk unassisted unless going straight to slaughter) but  
 463 requires appropriate certificate for slaughter. This farmer was fairly confident in their answer

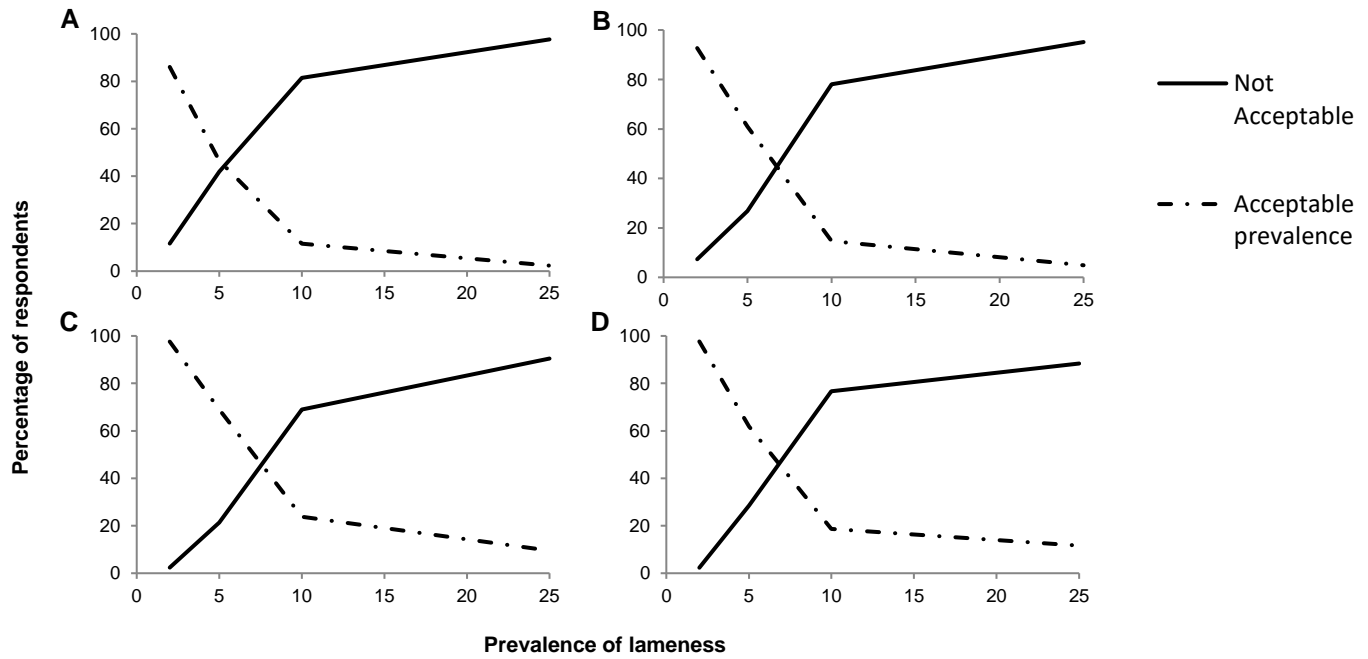


464 Table 4. Number and percentage of participants by attitude to animal welfare inspections for  
 465 lameness in their flock by the [geometric mean prevalence and 95% CI ] for lameness in ewes  
 466 between July 2013 – June 2014

Statement	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
I welcome inspection to check compliance with animal welfare legislation (N = 38)	2 [1.41, 0.02 – 115.6]	4 [4.5, 3.6 – 5.5]	15 (39.5%) [2.7, 2.0 – 3.7]	15 (39.5%) [3.0, 1.8 – 4.9]	2 [2.1, 0.03 – 173.4]
External inspections to check animal welfare wastes my time (N = 38)	1 [2, -]	12 (31.6%) [2.9, 1.5 – 5.6]	11 (28.9%) [2.6, 1.7 – 4.0]	14 (36.8%) [3.0, 2.3 – 3.9]	0
External inspections are important in maintaining animal welfare standards (N = 39)	1 [4, -]	15 (38.5%) [3.1, 2.3 – 4.2]	10 (25.6%) [2.2, 1.6 – 3.2]	12 (30.8%) [2.9, 1.5 – 5.5]	1 [3, -]
There is too much external inspection of animals in my flock (N = 39)	0	9 (23.1%) [1.9, 0.9 – 4.1]	25 (64.1%) [3.0, 2.4 – 3.9]	4 [4.2, 2.8 – 6.1]	1 [3, -]

467 Figure 1 Theme 1. 42 participants' attitudes of an acceptable prevalence of lameness for each  
 468 scenario. A. Farmer rarely treats lameness; B. Farmer has been using the same method to  
 469 manage lameness over 20 years; C. Farmer claims to use best practice and D. Prevalence  
 470 rapidly increases despite seeking and following veterinarian's advice. Where lines intersect  
 471 defines the average upper acceptable prevalence.

472



473

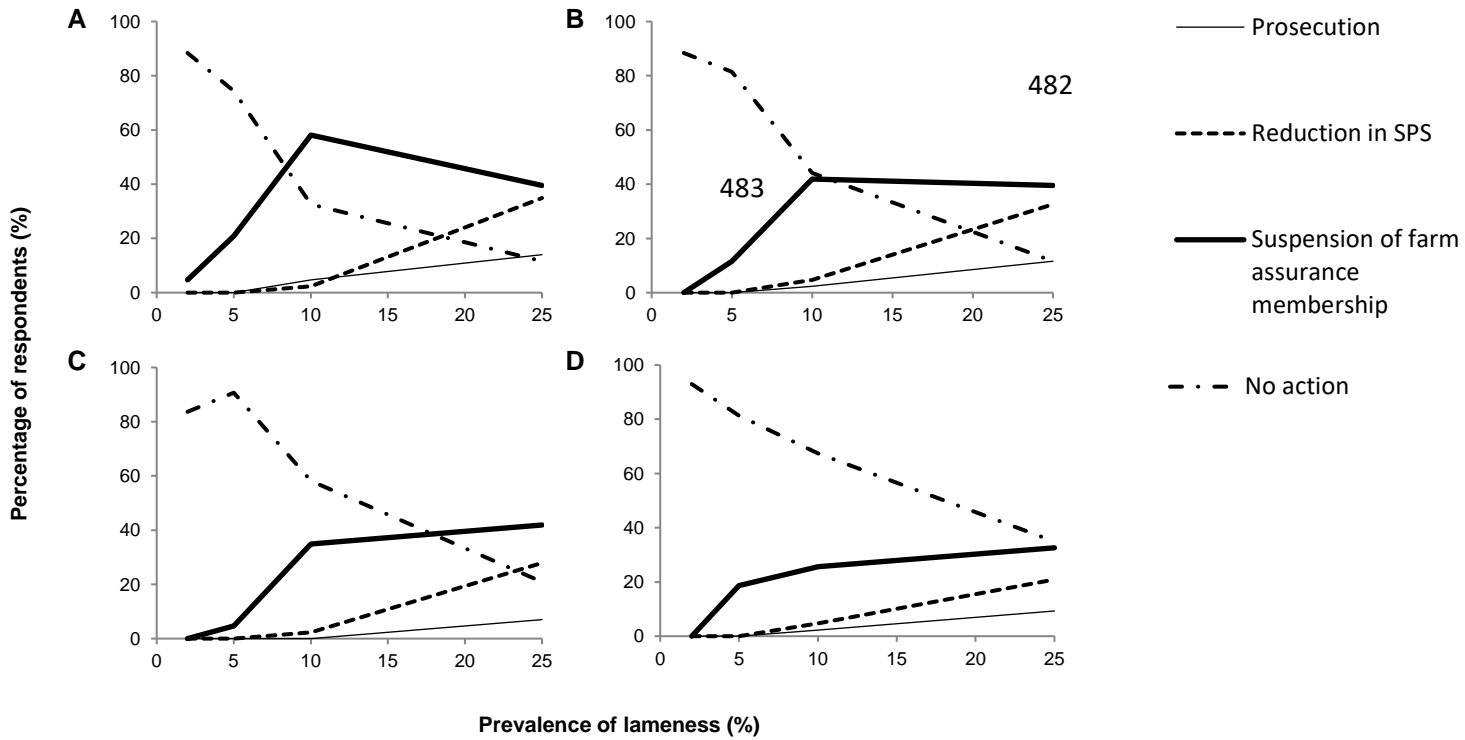
474

475

476

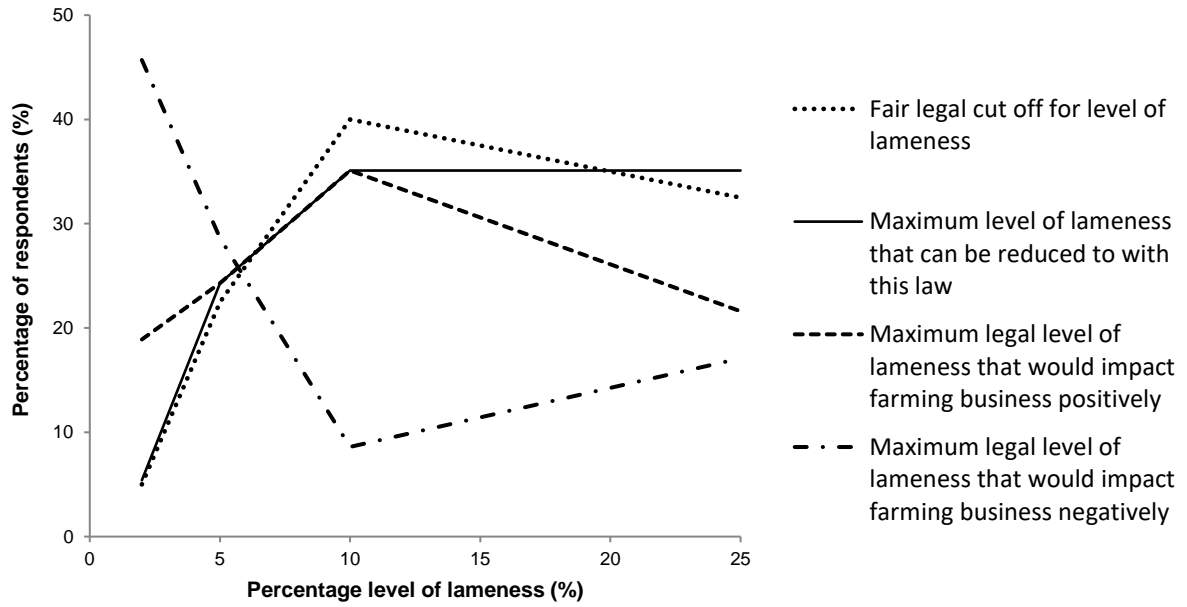
477 Figure 2 Theme 2. Participants' attitudes of a fair outcome for each scenario by A - D. A. A  
 478 farmer rarely treats lameness; B. Using the same method to manage lameness > 20 years;  
 479 A farmer that claims to use best practice D. Prevalence rapidly increases despite seeking and  
 480 following veterinarian's advice.

481



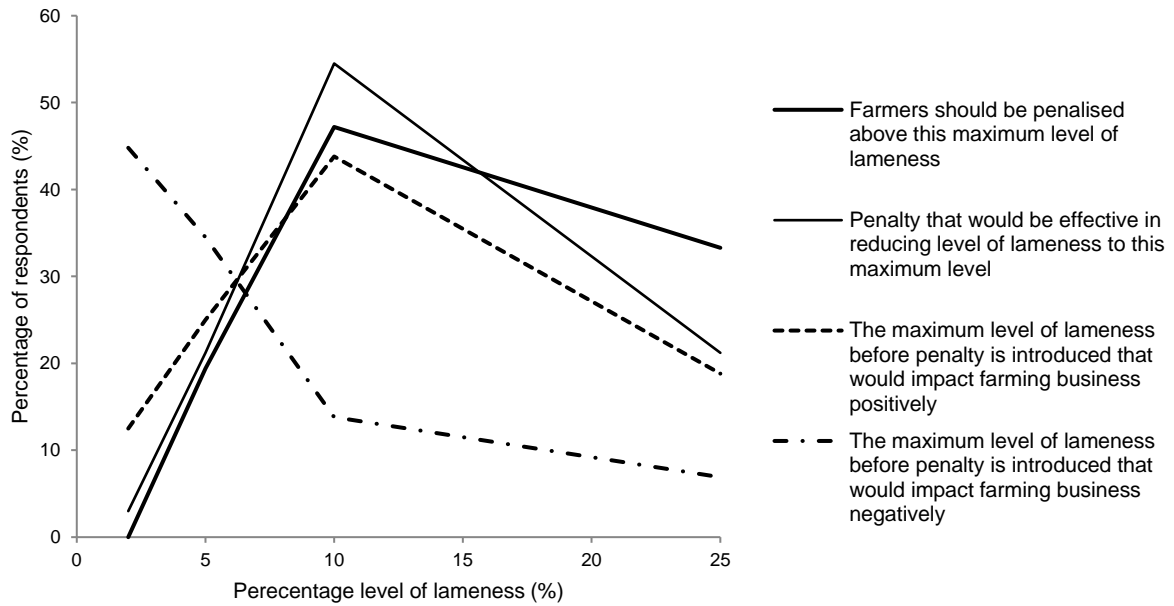
Rewards not shown in Figure due to small numbers

484 Figure 3 Theme 3. Attitudes of 42 English sheep farmers by percentage of participants on  
 485 how sheep farmers are rewarded or sanctioned for lameness in their flock  
 486  
 487 A. The fair legal cut-off for the maximum level of lameness in sheep flocks



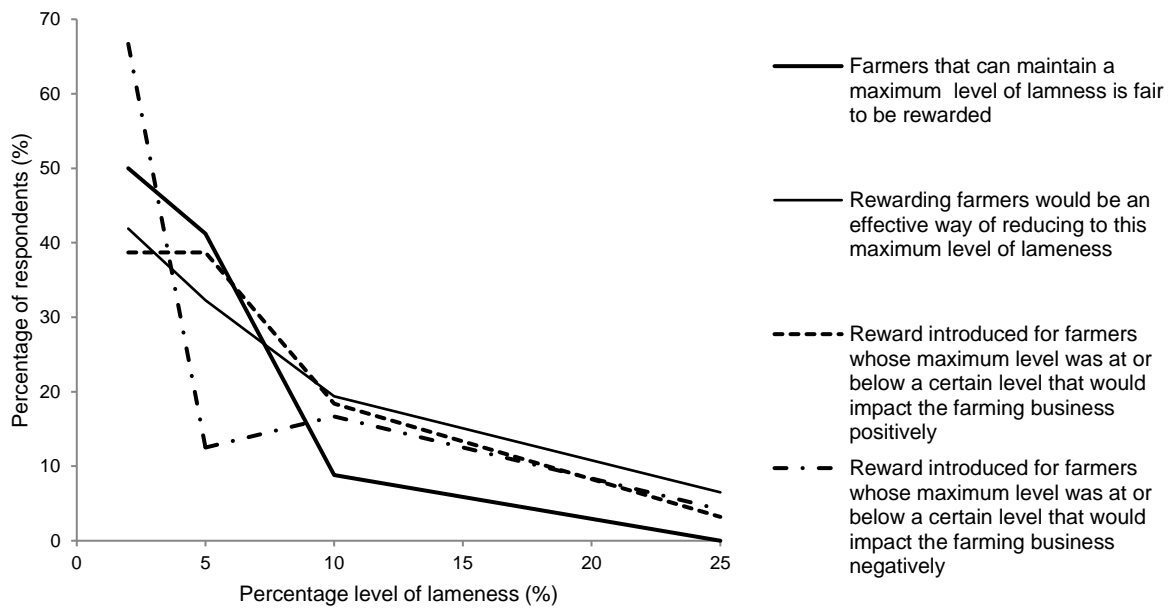
488

489 B. The prevalence of lameness above which a penalty should be introduced



490

491 C. The prevalence of lameness below which a reward should be introduced



492

493

494 **References**

- 495 **ADAS** 2008 Flock Health Planning in the West Midlands. In: A Report for Defra FFG  
 496 **Animal Welfare Act 2006** c 45 [www.legislation.gov.uk](http://www.legislation.gov.uk) retrieved 8<sup>th</sup> November 2006  
 497 **Balliet D, Mulder LB and Van Lange PA** 2011 Reward, punishment, and cooperation: a  
 498 meta-analysis. *Psychol Bull* 137(4): 594-615  
 499 **Bellet C, Woodnutt J, Green L E and Kaler J** 2015 Preventative services offered by  
 500 veterinarians on sheep farms in England and Wales: Opinions and drivers for proactive flock  
 501 health planning. *Preventive Veterinary Medicine* 122(4): 381-388  
 502 **Blaser J and Cornuz J** 2015 Experts' consensus on use of electronic cigarettes: a Delphi  
 503 survey from Switzerland. *BMJ Open* 5(4)  
 504 **Boyce C, Wood J and Ferguson E** 2016 Individual differences in loss aversion:  
 505 conscientiousness predicts how life satisfaction responds to losses versus gains in income.  
 506 *Personality and social psychology bulletin* 42: 471-484  
 507 **Clark CCA, Crump RE, KilBride AL and Green LE** 2016 Farm membership of voluntary  
 508 welfare schemes results in better compliance with animal welfare legislation in Great Britain.  
 509 *Animal Welfare* 25(4): 461-469  
 510 **Council regulation (EC) No 1/2005 on the protection of animals during transport and**  
 511 **related operations** [www.eur-lex.europa.eu](http://www.eur-lex.europa.eu) retrieved 22<sup>nd</sup> December 2004  
 512 **Defra** 2011 Non-formal consultation on proposals to reform the animal welfare inspection  
 513 regime. *Department for Environment Food & Rural Affairs: Policy Team, The National*  
 514 *Archives, Kew, Richmond, Surrey, TW9 4DU*  
 515 **Defra** 2013 Consultation on the reform of farm animal welfare codes. *Department for*  
 516 *Environment Food & Rural Affairs: Policy Team, The National Archives, Kew, Richmond,*  
 517 *Surrey, TW9 4DU*  
 518 **Defra** 2014 Independent Farming Regulation Task Force Implementation Group: Final  
 519 Assessment of Progress. *Department for Environment Food & Rural Affairs: Policy Team,*  
 520 *The National Archives, Kew, Richmond, Surrey, TW9 4DU*  
 521 **Defra** 2015a The guide to cross compliance in England. *Department for Environment Food*  
 522 *& Rural Affairs: Policy Team, The National Archives, Kew, Richmond, Surrey, TW9 4DU*  
 523 **Dickins A, Clark CCA, Kaler J, Ferguson E, O'Kane H, Green LE** 2016 Factors  
 524 associated with the presence and prevalence of contagious ovine digital dermatitis: A 2013  
 525 study of 1136 random English sheep flocks. *Preventive Veterinary Medicine* 130: 86-93  
 526 **Dowling GR and Staelin R** 1994 A Model of Perceived Risk and Intended Risk-Handling  
 527 Activity. *Journal of Consumer Research* 21(1): 119-134  
 528 **FAWC** 2011 Opinion on Lameness in Sheep. Farm Animal Welfare Council: London, UK  
 529 **Fehr E and Gächter S** 2002 Altruistic punishment in humans. *Nature* 415(6868): 137-140  
 530 **Ferguson E, Taylor M, Keatley D, Flynn N and Lawrence C** 2012 Blood donors' helping  
 531 behavior is driven by warm glow: more evidence for the blood donor benevolence  
 532 hypothesis. *Transfusion* 52(10): 2189-2200  
 533 **Ferguson E and Starmer C** 2013 Incentives, expertise and medical decisions: Testing the  
 534 robustness of natural frequency framing. *Health Psychology* 9: 967-977  
 535 **Fischhoff B, Slovic P and Lichtenstein S** 1978 How safe is safe enough? : a psychometric  
 536 study of attitudes towards technological risks and benefits. *Policy Science* 9: 127-152  
 537 **Fitzpatrick J, Scott M and Nolan AM** 2006 Assessment of pain and welfare in sheep. *Small*  
 538 *Ruminant Research* 62(1): 55-61  
 539 **Freeman TR and Bass MJ** 1992 Determinants of maternal tolerance of vaccine-related  
 540 risks. *Fam Pract* 9(1): 36-41  
 541 **Gneezy U, Meier S and Rey P** 2011 When and why incentives don't work to modify  
 542 behavior. *Journal of economic perspectives* 25:191-210

- 543 **Goddard P, Waterhouse T, Dwyer C and Stott A** 2006 The perception of the welfare of  
 544 sheep in extensive systems. *Small Ruminant Research* 62(3): 215-225
- 545 **Green LE, Kaler J, Wassink GJ, King EM, Grogono TR** 2012 Impact of rapid treatment  
 546 of sheep lame with footrot on welfare and economics and farmer attitudes to lameness in  
 547 sheep. *Animal Welfare* 21: 65-71
- 548 **Gurerk O, Irlenbusch B and Rockenbach B** 2006 The competitive advantage of  
 549 sanctioning institutions. *Science* 312(5770): 108-111
- 550 **Johnson BB** 2003 Communicating air quality information: Experimental evaluation of  
 551 alternative formats. *Risk Analysis* 23: 91-103
- 552 **Kahneman D and Tversky A** 1979 Prospect theory: an analysis of decision under risk.  
 553 *Econometrica* 47:263-291
- 554 **Kahneman D** 2011 Thinking , fast and slow. *New York:Farrar, Straus and Giroux*
- 555 **Kaler J and Green LE** 2008a Recognition of lameness and decisions to catch for inspection  
 556 among sheep farmers and specialists in GB. *BMC Veterinary Research* 4(41)
- 557 **Kaler J and Green LE** 2008b Naming and recognition of six foot lesions of sheep using  
 558 written and pictorial information: A study of 809 English sheep farmers. *Preventive*  
 559 *Veterinary Medicine* 83(1): 52-64
- 560 **Kaler J, Wassink GJ and Green LE** 2009 The inter- and intra-observer reliability of a  
 561 locomotion scoring scale for sheep. *Veterinary Journal* 180(2): 189-194
- 562 **Kaler J and Green LE** 2013 Sheep farmer opinions on the current and future role of  
 563 veterinarians in flock health management on sheep farms: A qualitative study. *Preventive*  
 564 *Veterinary Medicine*, 112(3-4): 370-377
- 565 **KilBride AL, Mason SA, Honeyman PC, Pritchard DG, Hepple S and Green LE** 2012  
 566 Associations between membership of farm assurance and organic certification schemes and  
 567 compliance with animal welfare legislation. *Vet Rec* 170(6): 152
- 568 **King EM and Green LE** 2011 Assessment of farmer recognition and reporting of lameness  
 569 in adults in 35 lowland sheep flocks in England. *Animal Welfare* 201:321-328
- 570 **King EM** 2013 Lameness in English lowland sheep flocks: farmer's perspectives and  
 571 behaviour. PhD thesis, University of Warwick
- 572 **Knowles T, Moody R and McEachern MG** 2007 European food scares and their impact on  
 573 EU food policy. *British Food Journal* 109(1): 43-67
- 574 **Ley SJ, Livingston A and Waterman AE** 1989 The effect of chronic clinical pain on  
 575 thermal and mechanical thresholds in sheep. *Pain* 3: 353-357
- 576 **Lotem A, Fishman MA and Stone L** 1999 Evolution of cooperation between individuals.  
 577 *Nature* 400(6741): 226-227
- 578 **Morris C and Young C** 2000 `Seed to shelf', `teat to table', `barley to beer' and `womb to  
 579 tomb': discourses of food quality and quality assurance schemes in the UK. *Journal of Rural*  
 580 *Studies* 16(1): 103-115
- 581 **NFU** 2015 NFU review of livestock farm inspections in England. Department for Business,  
 582 Innovation and Skills: London, UK
- 583 **O'Kane H, Ferguson E, Kaler J and Green LE** 2016 Associations between sheep farmer  
 584 attitudes, beliefs, emotions and personality, and their barriers to uptake of breast practice: The  
 585 example of footrot. *Preventative Veterinary Medicine*
- 586 **RSPCA** 2013a RSPCA welfare standards for sheep. The Royal Society for the Prevention of  
 587 Cruelty to Animals: West Sussex, UK
- 588 **RSPCA** 2013b RSPCA Prosecutions Department Annual report: Justice for Animals. West  
 589 Sussex, UK
- 590 **Sjoberg L** 2000 Factors in risk perception. *Risk Anal* 20(1): 1-11
- 591 **Slovic P** 1987 Perception of risk. *Science* 236(4799): 280-285

- 592 **Slovic P and Peters E** 2006 Risk Perception and Affect. *Current Directions in Psychological*  
593 *Science* 15(6): 322-325
- 594 **Statutory Management Requirements (SMRs) 2015** The guide to cross compliance in  
595 England 2015. *Department for Environment Food & Rural Affairs: Policy Team, The*  
596 *National Archives, Kew, Richmond, Surrey, TW9 4DU*
- 597 **The Welfare of Animals (Transport) (England) Order 2006** No. 3260  
598 [www.legislation.gov.uk](http://www.legislation.gov.uk) retrieved 5<sup>th</sup> January 2007
- 599 **The Welfare of Farmed Animals (England) Regulations 2007** No. 2078  
600 [www.legislation.gov.uk](http://www.legislation.gov.uk) retrieved 1<sup>st</sup> October 2007
- 601 **Traulsen A, Rohl T and Milinski M** 2012 An economic experiment reveals that humans  
602 prefer pool punishment to maintain the commons. *Proc Biol Sci* 279(1743): 3716-3721
- 603 **Tversky A and Kahneman D** 1974 Judgement under uncertainty: Heuristics and biases.  
604 *Science* 185:11124-11131
- 605 **Veterinary Record** 2016 Industry ‘disappointed’ as Defra backtracks on welfare codes.  
606 *Journal of the British Veterinary Association* 178(16): 383
- 607 **Wassink GJ, Grogono TR, Moore LJ and Green LE** 2003 Risk factors associated with the  
608 prevalence of footrot in sheep from 1999 to 2000. *Veterinary Record* 152(12): 351-358
- 609 **Wassink GJ, King EM, Grogono-Thomas R, Brown JC, Moore LJ and Green LE** 2010  
610 A within farm clinical trial to compare two treatments (parenteral antibacterials and hoof  
611 trimming) for sheep lame with footrot. *Preventive Veterinary Medicine* 96(1–2): 93-103
- 612 **Winter JR, Kaler J, Ferguson E, KilBride AL and Green LE** 2015 Changes in  
613 prevalence of, and risk factors for, lameness in random samples of English sheep flocks:  
614 2004–2013. *Preventive Veterinary Medicine* 122(1–2): 121-128
- 615 **Wood JD, Holder JS and Main DCJ** 1998 Quality Assurance schemes. *Meat Science* 49  
616 *Supplement 1*: S191-S203