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1 **Footrot and interdigital dermatitis in sheep: farmer satisfaction with current management,**
2 **their ideal management and sources used to adopt new strategies**

3

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11

12 **Abstract**

13 The aims of this research were to identify management practices that sheep farmers currently use
14 to treat and prevent footrot in sheep and whether they consider that these are successful
15 management tools and to find out how sheep farmers would ideally like to manage footrot in
16 their flock. Over 80% of lameness in sheep in the UK is caused by *Dichelobacter nodosus*,
17 which presents clinically as interdigital dermatitis (ID) alone or with separation of hoof horn
18 (FR). A questionnaire was sent to 265 farmers to investigate their current management and their
19 satisfaction with current management of the spectrum of clinical presentations of footrot.
20 Farmers were also asked their ideal management of footrot and their interest in, and sources of
21 information for, change. Approximately 160 farmers responded. Farmers satisfied with current
22 management reported a prevalence of lameness $\leq 5\%$. These farmers caught and treated lame
23 sheep within 3 days of first seeing them lame, and treated sheep with FR and ID with parenteral
24 antibacterials. Farmers dissatisfied with their management reported a prevalence of lameness
25 $>5\%$. These farmers practised routine foot trimming, footbathing and vaccination against footrot.
26 Whilst 89% of farmers said they were satisfied with their management of FR over 34% were
27 interested in changing management. Farmers identified veterinarians as the most influential
28 source for new information. Farmers reported that ideally they would control FR by culling /
29 isolating lame sheep, sourcing replacements from non-lame parents, trimming feet less, using
30 antibacterial treatments less and using vaccination more. Footbathing was a commonly used
31 management that was linked with dissatisfaction that also was listed highly as an ideal
32 management. Consequently, some of the ideal managements are in agreement with our
33 understanding of disease control (culling and isolation, sourcing healthy replacements) but others
34 are in contrast with our current knowledge of management and farmers self reporting of

35 satisfaction of management of footrot (less use of antibacterial treatment, footbathing and
36 vaccination). One explanation for this is the theory of cognitive dissonance where belief follows
37 behaviour i.e. farmers report that they believe an ideal which is what they are currently doing,
38 even if the management is sub optimal.

39 *Keywords:* sheep; lameness; farmer opinion; flock management; correspondence analysis

40 **1. Introduction**

41 Sheep farmers in the United Kingdom have stated that lameness in sheep is their highest
42 cause of concern for poor health (Goddard *et al.*, 2006). Footrot (FR) and interdigital dermatitis
43 (ID) (both presentations of *Dichelobacter nodosus* infection) cause over 90% of lameness in
44 sheep in the United Kingdom (Kaler and Green, 2008a). Over 90% of a random sample of 800
45 sheep farmers reported that they had sheep in their flock lame with FR and/or ID (Kaler and
46 Green, 2008a) and these farmers estimated that 8–10% of sheep in their flocks were lame with
47 FR or ID. These are similar estimates to those reported by Grogono-Thomas and Johnston (1997)
48 and Wassink *et al.* (2003, 2004). FR has been estimated to cost the sheep industry in Great
49 Britain £24 million per year (Nieuwhof and Bishop, 2005) or £80 million (Wassink *et al.*, in
50 press).

51 In the UK, the focus for many decades has been to prevent lameness caused by FR and
52 ID using whole flock managements of routine foot trimming, footbathing and vaccination
53 (Morgan, 1987). However, there is now a series of observational studies that suggest that these
54 practices are not beneficial and might be detrimental to the prevention or reduction of lameness
55 in sheep. Routine foot trimming of sheep once or more than once a year has been associated with
56 a higher flock-prevalence and -incidence of FR and ID compared with flocks where routine foot
57 trimming is not practised (Wassink *et al.*, 2003; Green *et al.*, 2007; Kaler and Green, 2009).

58 Footbaths have been reported to give cures of 61% – 77% after 42 days in the UK (Parajuli and
59 Goddard, 1989;Grogono-Thomas *et al.*, 1994), however, the use of footbathing has been
60 associated with a high prevalence of footrot in ewes (Kaler and Green, 2009), probably because
61 of the increased duration of FR disease compared with antibiotic treatment (see below) and only
62 of benefit in the control of ID in lambs (Wassink *et al.*, 2004). At present, the only vaccine
63 licensed for use against FR in the United Kingdom is the polyvalent serotype *D. nodosus* vaccine
64 Footvax (Intervet / Schering-Plough Animal Health). The effectiveness of this vaccine is low
65 because of antigenic competition (Schwartzkoff *et al.*, 1993; Raadsma *et al.*, 1994) and its use is
66 recommended in combination with individual treatment of sheep with FR.

67 There is observational and experimental evidence that treatment of individual lame sheep
68 is associated with a low prevalence of lameness in flocks. This treatment ideally includes
69 isolation (Wassink *et al.*, 2003), but definitely requires treatment of sheep lame with FR or ID
70 with parenteral and topical antibacterials within 3 days of first being seen lame (Wassink *et al.*,
71 in press; Kaler and Green, 2008b). This treatment leads to > 95% recovery from FR or ID with a
72 median time to recovery of 4 and 2 days respectively (Wassink *et al.*, in press) if hoof horn is not
73 trimmed / pared (Kaler *et al.*, 2010).

74 Some farmers are using some or all of the individual managements listed above: from
75 2000 – 2004, 70% - 90% of farmers used parenteral antibiotics to treat at least some sheep lame
76 with FR (Wassink *et al.*, 2003; Kaler and Green, 2009). Wassink *et al.* (2005) also reported that
77 60% of farmers considered parenteral antibiotics and topical foot sprays good or excellent
78 treatments for FR. However, in 2006, whilst 38% of 178 farmers were treating sheep within 3
79 days of seeing them lame, 15% never treated individual lame sheep (Kaler and Green, 2008b).
80 These results indicate that a group of farmers are promptly treating lame sheep. This is a labour

81 intensive approach to management of lameness and to understand whether the industry is likely
82 to adopt such management it would be useful to know whether this group of farmers considers it
83 time and money well spent and what an ideal management of lameness would be.

84 Rehman *et al.* (2007) highlighted that promotion of a new technology and transfer of
85 knowledge need to take account of the beliefs and attitudes of potential adopters. Currently little
86 is known about sheep farmers' attitudes to management of diseases. The Theory of Reasoned
87 Action, subsequently the Theory of Planned Behaviour (Ajzen, 1991), has been adopted as a
88 theoretical framework to understand how psychological factors impact on decisions (Willock *et*
89 *al.* 1999). In many farming systems financial implications drive decision making because farms
90 are businesses, however, normative theory, that farmers are simple profit maximisers often fails
91 to fit the data when modelling farmer decisions (Willock *et al.*, 1999). One explanation for this in
92 the UK is that sheep farmers have been subsidised for decades and many are unaware of where
93 they gain and lose income. Whilst there are fairly crude national estimates of costs of disease e.g.
94 footrot costs the UK sheep industry between 24 and 80 million pounds sterling (Nieuwhof and
95 Bishop, 2004; Wassink *et al.*, in press), there is only one estimate of loss of income from a
96 within farm study (Wassink *et al.*, in press) of £6 per ewe mated. Consequently it is difficult for
97 sheep farmers to estimate how endemic diseases impact on income on their farm. Another
98 explanation is that there are other drivers for management of disease that are not financially
99 motivated.

100 In this paper we used the 2006 managements of FR and ID to identify those which
101 farmers thought most effective and compared farmer satisfaction with current managements. We
102 then investigated farmers' ideal approaches to management and where they sourced new ideas to
103 manage FR and ID.

104

105 **2. Materials and Methods**

106 In November 2006, a questionnaire was sent to 265 compliant English lowland farmers
107 sourced from the 800 farmers who participated in Kaler and Green (2008a) to obtain information
108 on farmers' current satisfaction with, and ideal management of, FR and ID. In addition,
109 information was gathered on farmers' interest in change, and sources of information that farmers
110 used to gather new ideas.

111 The questionnaire was developed using published literature and knowledge from the
112 lameness research group at the University of Warwick. Participants were asked to estimate the
113 prevalence of lameness in their ewes and lambs in 2005 and 2006. Farmers were asked to rank
114 up to five practices that they currently used to prevent i) FR and ii) ID and up to three current
115 practices that they used to treat i) FR and ii) ID from semi-open lists (e.g. Table 1) that were
116 provided. Farmers were then asked to rank up to five managements that they would ideally use to
117 prevent FR and ID and up to three ideal managements to treat these two conditions. Farmers
118 were also asked their overall satisfaction with their current management of FR and ID on a 5-
119 point Likert scale (O'Keefe, 2002) of 'very satisfied, satisfied, neither satisfied nor dissatisfied,
120 unsatisfied, very unsatisfied', with a 'don't know' option and a 3-point scale of 'yes, possibly,
121 no' on whether they would consider changing their management. Finally, farmers were asked to
122 rank a maximum of five sources of information from which they gained new knowledge of
123 management of lameness by currently used, ideally use and most influential again from a semi-
124 open list.

125 Data were entered into Access 2003 and analysed in Stata 10 (StataCorp, USA). The
126 ranked responses were weighted for importance; the management ranked number 1 by the farmer

127 was awarded 5 points, number 2 with 4 points, down to number 5 with 1 point. The management
128 ranked number 1 always started with 5 points even if the farmer gave <5 managements. Within
129 farmer differences between 'current' and 'ideal' management were tested using a Wilcoxon
130 matched-pairs signed-rank test (Sheskin, 2000). An extension of the Wilcoxon rank-sum test was
131 used to compare the prevalence of lameness between flocks owned by satisfied and dissatisfied
132 farmers and between flocks where farmers were interested or not interested in change in
133 management of FR and ID (Cuzick, 1985).

134 The prevalence of lameness in ewes was categorised at the median into a binary variable
135 of $\geq 5\%$ compared with $< 5\%$. Current managements were compared with the prevalence of
136 lameness using binomial logistic regression analysis (Hosmer and Lemeshow, 2001). The
137 variables with a crude likelihood ratio chi-squared probability < 0.25 were tested in a
138 multivariable model using backward elimination, to estimate adjusted levels of association. All
139 the exposures excluded (for all levels of significance) were then re-tested in the final model (Cox
140 and Wermuth, 1996) to ensure that any residual confounding was identified.

141 Associations between current management and binary codes for satisfaction,
142 effectiveness, interest in change, value for money and time and whether the managements
143 worked were investigated using multiple correspondence analysis (MCA) (Coelho *et al.*, 2008).
144 A univariable binomial complementary (c) log-log regression analysis (Hilbe, 1996) was used to
145 determine associations between attitudes and management of FR and ID. Variables with a crude
146 likelihood ratio chi-squared probability < 0.25 were tested in a multivariable log-log model using
147 backward elimination, to estimate associations between attitudes and current management of FR
148 and ID.

149

150 **3. Results**

151 The number of responses was 172 after two reminders, a response of 65%. Eleven
152 questionnaires were not usable because farmers did not have any sheep or did not report the
153 prevalence of lameness and consequently the overall useable response was 61%; not all
154 respondents answered all questions. The median flock size was 275 (IQR: 120 – 550) with a
155 mean of 397 in 2006. The farmer estimated mean and median percent lameness in ewes and
156 lambs was 6.9% and 5 (IQR: 3 – 10) 7.0%, mean 5 (IQR: 2 – 10) respectively. Ninety-one (60%)
157 respondents kept ≤ 4 ewes per acre.

158

159 *3.1 Farmer current and ideal management of lameness*

160 Overall 154 farmers listed at least one to five management practices used to prevent
161 footrot, with 143 (88%) listing 5. The top five were foot trimming FR diseased feet, footbathing
162 the flock, treating FR with topical sprays, treating FR with parenteral antibiotics and foot
163 trimming the flock (Table 2). These managements still scored highly as ideal treatments but the
164 scores for all five managements fell significantly. Managements that increased significantly in
165 score were quarantine diseased sheep, cull lame sheep immediately, purchase sheep from farms
166 with low levels of lameness, source replacements from non-lame ewes and vaccinate the flock
167 once or twice per year (Table 2). Overall, 107 (66%) farmers indicated five managements to
168 prevent ID. The current and ideal managements were the same (Table 2) but again, farmer
169 current managements tended to fall in score. Ideal managements were the same as those for FR
170 with the addition of quarantine new sheep and reduce stocking density (Table 2). The current and
171 ideal managements to treat FR were foot trimming, topical antibiotics sprays and footbathing.

172 Vaccination had a significantly higher cumulative score as an ideal treatment than a current
173 treatment (Table 3).

174

175 *3.2 Associations between current management and prevalence of lameness*

176 Not all farmers answered every question. In the estimates below the number of farmers who
177 answered the question is used as the denominator. Eighty-seven (55%), 19 (12%), and 53 (33%)
178 farmers checked their flock for lameness every day, twice a week and once a week or less,
179 respectively. Nineteen (13%), 76 (50%), 49 (32%) and 7 (5%) farmers treated lame sheep on the
180 day they were first seen lame, within 3 days, within one week and within two weeks
181 respectively; nearly all farmers (158 (98%)) treated lame sheep with 70 farmers (49%) treating
182 when 1 or 2 were seen lame and 17 (12%) not treating individuals until 10 or more sheep in a
183 group were lame. Forty-six (28%) and 47 (29%) respondents did not catch lame sheep for
184 treatment when lambs were very young or rams were with ewes, respectively. Twenty-seven
185 (17%), 52 (33%) and 79 (50%) farmers routinely inspected the feet of all ewes on 0, 1 or ≥ 2
186 occasions respectively in 2006. Among the farmers who routinely inspected sheep feet, 31 (22%)
187 trimmed 100% of the ewes' feet and a further 22 (16%) trimmed $>50\%$; 71 (46%) farmers
188 footbathed their flock on ≥ 3 occasions in 2006.

189 Results from the multivariable analysis (Table 4) with the outcome lameness $\geq 5\%$ were
190 that footbathing \geq twice a year (OR=2.4), routine foot inspection \geq once a year (OR=4.7),
191 rotational grazing (OR=2.8), purchasing rams from flocks with low levels of lameness (OR=5.1)
192 and > 3 days between seeing a sheep lame and treating it (OR=4.1) were associated with a
193 prevalence of lameness $\geq 5\%$. Replacing ewes with ewe lambs from non-lame ewes was
194 associated with a lower prevalence of lameness (OR=0.2).

195 3.3 *Satisfaction of farmers with their current management of lameness and interest in change*

196 The majority of respondents had a positive attitude to their management of lameness with
197 only 11% of farmers very dissatisfied or dissatisfied (Table 5). The more dissatisfied farmers
198 were, the higher the prevalence of lameness they reported in both ewes and lambs ($P<0.01$).
199 When respondents were asked whether they thought that the managements they used made the
200 best use of their time and money, 80 (49%) and 74 (46%) answered 'yes', and 75 (46%) and 64
201 (40%) answered 'to some extent' respectively whilst 80 (49%) thought the managements that
202 they used worked and a further 80 (49%), thought they worked 'to some extent'. Fifty-three
203 (34%) sheep farmers were interested in change.

204 There was a significant ($p<0.05$) positive association between very satisfied / satisfied
205 with management and treatment in <3 days from observing sheep lame and treating sheep when
206 only 1 or 2 in a group were lame. Treating lame sheep when only 1 or 2 were lame was also
207 associated with 'management works' and 'makes best use of time'. Purchasing rams from farms
208 with a low prevalence of lameness was positively associated with 'no' to interest in change in
209 management. Vaccination of the flock once a year was associated with a lack of satisfaction with
210 management and a negative response to management works and makes best use of money.
211 Footbathing to prevent lameness was negatively associated with management made best use of
212 money and footbathing to treat lameness was positively associated with an interest in change.
213 Inspecting the feet of all the ewes more than once a year was negatively associated with best use
214 of time, treating ewes with topical spray and culling lame sheep at weaning to prevent FR and ID
215 were negatively associated with best use of money and a negative response to the management
216 worked. Reduced stocking density for prevention was positively associated with best use of time.

217 Farmers who were very satisfied with their management of lameness were less likely to
218 want to change management (Figure 1). Management works, makes good use of money and of
219 time were associated with both satisfied and very satisfied with management of lameness. The
220 reverse association was also present. Farmers who ‘possibly want to change management’ were
221 dimensionally linked to satisfied and neither satisfied nor unsatisfied, indicating less association
222 between interest in change and satisfaction with lameness; dimension 1 (x-axis) explained (94%)
223 of the inertia.

224

225 3.3 Sources of knowledge for management of lameness

226 The highest ranked route for new knowledge in 2006, the most ideal and of greatest
227 influence was veterinary consultation (Table 6). The next most used sources were ‘The Farmers
228 Weekly’ and information from other farmers, with the latter regarded as relatively influential. In
229 the ideal situation farmers said that they would use DEFRA (Department of Environment, Food
230 and Rural Affairs), EBLEX (English Beef and Lamb Executive), the internet and farm visits
231 more than currently used and ‘The Farmers Weekly’ and communication with other farmers less.
232 Farmers who listed ‘The Sheep Farmer’ and attended a day meeting of sheep farmers in 2006
233 reported a significantly higher prevalence of lameness in their flock ($P<0.05$).

234

235

236 4. Discussion

237 This study contributes to our understanding of satisfaction with current managements of
238 sheep lame with FR and ID: as such it is not a study of cause and effect, but of association, hence
239 its cross sectional design that linked current management and current prevalence of lameness

240 with current satisfaction. Satisfaction with management of FR and ID nationally is likely to be
241 less than the 68% in the current study, given the lower than national average prevalence of
242 lameness (a good correlate to prevalence of FR and ID (Kaler and Green, 2009)). Although these
243 farmers were not representative of all English sheep farmers, they provided a group of farmers,
244 some of whom were managing lameness successfully, that we could use to compare management
245 with satisfaction, interest in change and sources of information.

246 The results are generally as might be anticipated with those farmers who are using
247 prompt individual treatment (as reported by themselves and the evidence base from research)
248 satisfied with the efficacy and cost effectiveness of this approach and reporting a lower
249 prevalence of lameness. Farmers' ideal managements also included isolation and culling of lame
250 sheep and selecting replacements from unaffected stock, all likely to contribute to a low
251 prevalence of lameness when in combination with prompt treatment (Skerman and Moorhouse,
252 1987; Wassink *et al.*, 2005; Green *et al.*, 2007; Wassink *et al.*, in press). In the UK, farmers are
253 not able to transport lame sheep. This might be why farmers reported that 'ideally' they would
254 cull lame sheep but presently they do not. In reality, they are not prepared to cull and lose the
255 value of the sheep. In Australia there was a period of time at the start of the eradication
256 programme in NSW when lame sheep could be sold to specific markets and only for slaughter.
257 Transport of lame sheep is not likely to ever be legal in the UK and removing sheep that might
258 be carriers of *D. nodosus* will be at a financial cost. This could be a stumbling block for removal
259 of carrier sheep.

260 Whilst many ideal managements were in agreement with our understanding of the
261 treatment and prevention of FR and ID some were counter intuitive: farmers ranked footbathing
262 and vaccination higher in their ideal management of FR and ID than currently, although they

263 were still absolutely less popular than foot trimming and antibacterial treatments. One
264 explanation for this inconsistency, or dissonance, between the farmer ideal and currently
265 effective managements is that farmers have changed their attitude to fit their behaviour
266 (Festinger and Carlsmith, 1959): farmers do not wish to appear irrational and so reinforce their
267 current management by raising the management in their ranking. This is an example of cognitive
268 dissonance (Festinger, 1957) where people change their beliefs to match their behaviour, even if
269 they know that their behaviour is sub optimal, in this case, farmers endorse ‘ideally’ using
270 footbathing and vaccination because they already use it, despite considering these managements
271 poor use of time / money. Another explanation is that farmers would ‘ideally’ like to manage
272 lameness using flock managements such as an effective vaccine or effective routine footbathing.

273 Flock managements that are ineffective rank highly in current and ideal managements
274 suggesting, despite dissatisfaction, so a third explanation is that many farmers do not know what
275 is effective and do not have access to correct information. This fits with farmers reporting
276 veterinarians as the most influential, ideal and currently used source for information on
277 management of lameness. Unfortunately from our data, changes that farmers made to
278 management of lameness after veterinary advice were inconsistent and ranged from using
279 vaccination and increasing foot trimming to stopping trimming feet and using antibacterials.
280 Thus, the best practice management of lameness needs to be known by veterinarians to ensure
281 that they use the most recent evidence base for providing advice. In the UK there are relatively
282 few specialist sheep veterinarians, and relatively few sheep farmers on flock health contracts
283 with vets or advisors where there is time and investment on both sides to ensure that current
284 evidence is known and disseminated. Many of the farmers in this study would be using a non
285 specialist sheep vet.

286 Farmers' scores indicated that they would ideally use fewer individual treatments,
287 especially parenteral antibiotics and topical antibacterial sprays, despite the fact that the satisfied
288 farmers in the current study used this management and it is perceived that these treatments are
289 good or excellent in previous research (Wassink *et al.*, 2005). This may be because an individual
290 treatment is less easy to include in a flock management programme and relies on close
291 observation of the flock and responses to lame sheep at 'inconvenient times'. However, the 15%
292 of farmers that did not treat individual lame sheep in the study by Kaler and Green (2008b)
293 reported a median flock-prevalence of lameness of 15%, compared with a median of 5% among
294 the 38% who treat mildly lame sheep within 3 days of observing them lame. This does highlight
295 that at the present time, prompt treatment of lame sheep is the most effective in reducing the
296 prevalence and incidence of lameness in a flock (Green *et al.*, 2007; Wassink *et al.*, in press;
297 Kaler and Green, 2008a) and results from the current study.

298 The results from the current study highlight that careful thought needs to be put into
299 knowledge transfer. Where we have infectious diseases (and lameness in sheep in the UK is
300 primarily caused by *D. nodosus*), where good vaccines are not likely to be developed because of
301 the nature of the pathogen and host responses (Green, 2005) or where many pathogens can cause
302 one disease presentation e.g. mastitis in cattle, pneumonia in calves, we need to ensure that there
303 is industry-wide understanding and adoption of the benefits of treatment of affected individuals
304 to control transmission of infection in the flock or herd.

305 Farmers highlighted that they like to attend meetings on farms to gain new information.
306 In the current study, farmers who attended day meetings or read 'The Sheep Farmer' reported a
307 higher prevalence of lameness in their flock, either indicating that that they were less aware of
308 current best managements or that they were tolerant to the level of lameness. Attendance at

309 meetings might indicate that they were seeking knowledge to reduce levels of lameness. There
310 was an increase in rank score for both EBLEX and DEFRA as ideal sources of information,
311 suggesting that a higher input from these bodies would be accepted. The internet was not widely
312 used by the sheep farming community and is thus not a useful route of communication currently.
313 Batte (2005) reported that significantly fewer livestock farmers adopted computer technology
314 compared with other groups of farmers in his survey of computer use in Ohio, United States. The
315 slight increase in score in an ideal context suggests that the potential for this medium was
316 recognised by farmers but was not accessible or not used at the time of the survey.

317 Results from the current study might indicate that research on flock control measures for
318 lameness would be well received. Given that farmers prefer not to routinely trim feet, and
319 considered it a poor use of their time, and given that the evidence to date suggests that trimming
320 feet is not associated with lower prevalence (Wassink *et al.*, 2003, 2005; Green *et al.*, 2007;
321 Kaler and Green, 2008a) foot trimming would be a useful area for further research that, should
322 routine foot trimming be ineffective or detrimental, would be readily accepted by the end-user.

323 The flocks in this study had a farmer-estimated mean prevalence of lameness of 7%, less
324 than the national average of 10% (Kaler and Green, 2008a), probably because they were a
325 compliant group of farmers interested in lameness in sheep, but similar to the prevalence of
326 lameness that these farmers reported when they participated in Kaler and Green (2008a). We can
327 be reasonably confident of farmers' estimates of the prevalence of lameness in sheep. Sheep
328 farmers are able to recognise even mildly lame sheep in video clips and estimates of prevalence
329 of lameness in their own flock correlate logically with their reported rate of treatment (Kaler and
330 Green, 2008b). More recently, 35 sheep farmers were visited and their estimate of the prevalence
331 of lameness in their flock was compared with that of a trained researcher who observed the sheep

332 on the same day; the estimates, which ranged from 2 – 25% were >80% correlated between the
333 farmer and researcher, (King, personal communication). This is contrary to cattle farmers who
334 appear unable to estimate lameness in their herds (Leach *et al.*, 2010) but it does mean that we
335 can be fairly confident that sheep farmers who participated in the current study reported the
336 prevalence of lameness in their flock with some accuracy.

337

338 **5. Conclusions**

339 We conclude that sheep farmers who are satisfied with their management of FR and ID
340 have a mean prevalence of lameness of <5% and consider that they have a good use of time and
341 money with treatment of lame sheep within 3 days of observing them lame. Sheep farmers who
342 are dissatisfied are using flock control measures such as foot trimming, foot bathing and
343 vaccination instead. Counter intuitively, in an ideal situation, some farmers would prefer to use
344 whole flock control measures, this might be an example of cognitive dissonance. The evidence to
345 date is that FR and ID, along with many other transmissible diseases, are best managed through
346 prompt treatment of individuals. There is a challenge to explain the relationship between
347 individual and population management of disease when transferring knowledge to farmers.
348 Farmers look to their veterinary surgeons and day meetings to gather new information on
349 management of lameness. Consequently these two routes might be the optimal for transfer of
350 evidence-based medicine. Improved vaccines or other rapid flock management tools are likely to
351 be well received by farmers.

352

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356

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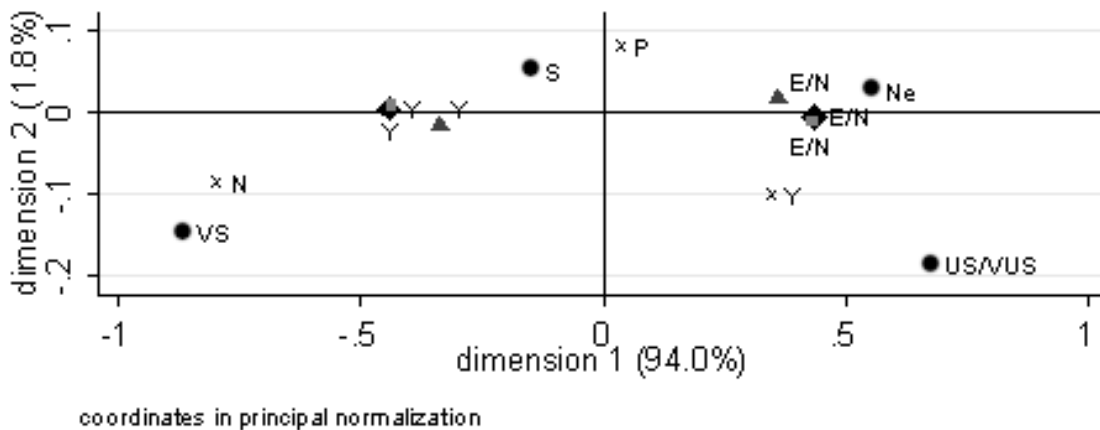
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437

438 **Fig. 1.** Multiple correspondence analysis (MCA) of satisfaction with lameness management,
 439 willingness to change methods, whether methods worked, and whether it made best use of
 440 money and ti **Fig. 1.** Multiple correspondence analysis (MCA) of satisfaction with lameness
 441 management, willingness to change methods, whether methods worked, and whether it made
 442 best use of money and time
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447 ● satisfaction: VS – very satisfied, S – satisfied, Ne – neither satisfied nor unsatisfied,

448 US/VUS – unsatisfied/very unsatisfied

449 ◊ time: Y – yes, E/N – to some extent/no

450 ■ money: Y – yes, E/N – to some extent/no

451 ▲ methods worked: Y – yes, E/N – to some extent/no

452 x change: Y – yes, P – possibly, N – no

453

454 **Table 1**

455 Example of question collecting data on managements to prevent footrot

456

457 **C1.1** Please list in the centre column of the table below the **top 5 managements that you used**

458 **to prevent footrot in ewes** in 2006, number the options from 1 (most important) down to 5

459

Prevention of footrot	Management in 2006	Ideal management
Cull lame sheep immediately		
Cull lame sheep at weaning		
Footbath group with footrot		
Footbath whole flock		
Foot trim sheep with footrot		
Foot trim all sheep in flock		
Purchase ewes from farms with low levels of lameness		
Purchase rams from farms with low levels of lameness		
Quarantine ewes with footrot		
Quarantine new sheep		
Reduce stocking density		
Replace ewes with ewe lambs born to non-lame ewes		

Rotational grazing		
Treat ewes with footrot with injectable antibiotics		
Treat ewes with footrot with topical spray		
Use set stocking		
Vaccinate flock with Footvax once per year		
Vaccinate flock with Footvax twice per year		
Vaccinate rams prior to tupping		
Other <i>(please state)</i> _____		
Other <i>(please state)</i> _____		

460

461 **C1.2** Now, please repeat this in the right hand column of the table above for your **ideal**

462 **management to prevent footrot in ewes**

463

464

465 **Table 2**

466 Top five managements used to prevent FR and ID in 2006 and top five ideal managements.

Prevention	FR			ID		
	No.	Cumulative score ^a	rank	No.	Cumulative score ^a	rank
		Current	Ideal		Current	Ideal
Foot trim lame [!] sheep	106	429	193 ^{**}	75	280	160 ^{**}
Footbath whole flock	87	356	303 [*]	100	379	397
Treat lame [!] ewes with topical spray	103	309	129 ^{**}	108	371	261 ^{**}
Treat lame [!] ewes with parenteral antibiotics	79	236	153 ^{**}	66	182	147 ^{**}
Foot trim flock	63	213	151 [*]	44	144	134
Footbath group with lame [!] sheep	48	148	91 ^{**}	69	286	230 [*]
Cull lame [!] sheep at weaning	41	111	113	27	64	87
Rotational grazing	40	97	80 [*]	43	121	143
Quarantine lame [!] ewes	26	80	130 [*]	30	79	132
Quarantine new sheep	25	76	90	26	69	111 ^{**}
Vaccinate flock against FR once / year	18	69	147 ^{**}	-	-	-
Reduce stocking density	19	42	56	18	54	79 [*]
Purchase rams from farms with low levels of lameness	18	36	91 ^{**}	12	20	54 [*]
Replacements from non-lame ewes	12	33	81 ^{**}	11	25	52 [*]
Purchase ewes from farms with low levels of lameness	12	25	113 ^{**}	10	26	82 [*]
Use set stocking	11	23	17	-	-	-
Vaccinate rams before mating	9	21	33	-	-	-
Cull lame [!] sheep immediately	7	15	182 ^{**}	6	11	57 ^{**}
Vaccinate flock against FR twice/ year	1	5	63 ^{**}	-	-	-

467 The ranked responses were weighted and summed for each management to give a total score

468 a: Wilcoxon matched-pairs signed-ranks test: * $P < 0.05$, ** $P < 0.01$

469 No.: Number of farmers ranking a method in the top 5 from a total of 161

470 !Lame with FR or ID respectively

471

472

473 **Table 3**

474 Top three managements used to treat FR and ID in 2006 and three ideal managements.

Condition	FR			ID			
	No.	Cumulative score ^a		rank	No.	Cumulative score ^a	
		2006	Ideal			2006	Ideal
Foot trim	125	574	509**	99	421	394	
Topical antibacterial spray	112	492	405**	123	560	510**	
Footbath	102	485	484	115	535	583**	
Parenteral antibacterials	70	383	335**	58	314	308	
Vaccination	18	115	270**	-	-	-	
Painkiller	2	27	35	4	40	59*	

475 The top three ranked responses weighted and summed for each management to give a total score

476 a: Wilcoxon matched-pairs signed-ranks test: * $P < 0.05$, ** $P < 0.01$

477 No.: Number of farmers ranking a method in the top 3 from a total of 161

478

479

480

481 **Table 4**
 482 Multivariable logistic regression model identifying managements associated with a reported
 483 prevalence of lameness in the ewe flock of $\geq 5\%$, 5% was the median value for lameness reported
 484 by farmers

Variable	No.	%	OR ^a	95 per cent CI	LR χ^2	P value
No. times whole flock footbath						
≤ 2 /year	73	6.6	1.00			
> 2 /year	65	7.0	2.38	1.09- 5.23	8.80	<0.01
Inspect feet of all ewes						
≤ 1 /year	68	5.9	1.00			
> 1 /year	70	7.7	4.71	2.02-10.95	14.94	<0.01
Rotational grazing						
Not in top 5	90	6.6	1.00			
In top 5	48	7.1	2.82	1.21-6.60	20.87	<0.01
Purchase rams from farms with low prevalence of lameness						
Not in top 5	119	6.6	1.00			
In top 5	19	8.0	5.14	1.59-16.62	24.84	<0.01
Time between observing lame sheep and catching						
≤ 3 days	86	5.3	1.00			
> 3 days	52	9.2	4.11	1.75-9.69	30.94	<0.01
Replace ewes with ewe lambs born to non-lame ewes						
Not in top 5	121	7.0	1.00			
In top 5	17	5.8	0.19	0.05-0.80	36.93	<0.01

485 No.: Number of farmers, %: prevalence, OR: odds ratio, 95 per cent CI: 95 percent confidence
 486 interval, LR χ^2 : likelihood ratio chi-square, df: degrees of freedom, \div^2 P value: probability of chi-
 487 square

488 a: Number of ewes in the flock forced into model as binomial data of <400 and ≥ 400

489
 490

491

492 **Table 5**

493 Farmer satisfaction with and interest in change in lameness management by prevalence of
 494 lameness in the flock in 2006

Response	No. (%)	Ewe lameness prevalence (%)	Lamb lameness prevalence (%)
Satisfaction with management			
very satisfied	17 (11)	4.1	2.7
satisfied	93 (58)	6.5	6.5
neither satisfied nor unsatisfied	34 (21)	8.0	9.2
unsatisfied/very unsatisfied	17 (11)	9.8	9.3
<i>Test for trend*</i>		<i>z=4.16 P<0.01</i>	<i>z=3.93 P<0.01</i>
Interest in change			
yes	53 (34)	8.5	8.0
possibly	81 (51)	6.8	7.4
no	24 (15)	3.9	3.3
<i>Test for trend*</i>		<i>z=-2.85 P<0.01</i>	<i>z=-3.66 P<0.01</i>

495 * test is an extension of the Wilcoxon rank-sum test

496

497

498 **Table 6**
 499 Number of farmers and cumulative rank score of source of new information on the management
 500 of lameness in 2006, ideal source and in their most influential source.

Source of Information	No.	Cumulative score ^a		
		2006	Ideal	Most influential
My Vet	108	475	464	553 ^{**}
“Farmers Weekly” [†]	70	238	169 ^{**}	125 ^{**}
Another sheep farmer	72	232	163 ^{**}	208
EBLEX fact sheets	65	201	247 [*]	190
DEFRA publications	59	163	206 [*]	158
An evening meeting of sheep farmers	42	148	114	104 [*]
“The Sheep Farmer” [†]	41	145	113	105 [*]
Day meeting of sheep farmers	22	75	65	84
Visit to sheep farm	19	53	78	82 ^{**}
My advisor	18	55	62	48
Own knowledge	17	84	34 ^{**}	43 [*]
The internet	12	33	79 ^{**}	34
“Farmers Guardian” [†]	2	9	9	13
SAC letter	1	5	5	0
NSA	2	9	8	10

501 a: Wilcoxon matched-pairs signed-ranks test between preferred and 2006 and between most
 502 influential and 2006:

503 * $P < 0.05$, ** $P < 0.01$

504 No.: Number of farmers ranking a method in the top 5 from a total of 161

505 [†]magazines read by farmers

506

507

508