Original Article

Cost-benefit analysis of management practices for ewes lame with footrot

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Abstract

The study aims were to investigate the cost-benefit of different strategies to treat and control ovine footrot. In November 2006, 162 sheep farmers responded to a survey on prevalence and management of lameness. Reading University's Farm Health Planning footrot calculator was used to calculate costs of lameness per ewe per year (PEPY) for 116 flocks. Linear regression was used to model the overall cost of lameness PEPY, by management method. Associations between farmer satisfaction and time and money spent managing lameness were investigated.

The median prevalence of lameness was 5% (inter-quartile range [IQR]: 4-10%). The overall cost of lameness PEPY in flocks with ≥10% lameness was £6.35 versus £3.90 for flocks with <5% lameness. Parenteral antibiotic treatment was associated with significantly lower overall cost of lameness by £0.79 PEPY. Routine foot trimming and footbathing were associated with significantly higher overall costs of lameness PEPY of £2.96 and £0.90 respectively.

Farmers satisfied with time managing lameness spent significantly less time (1.46 hours PEPY) than unsatisfied farmers (1.90 hours PEPY). Farmers satisfied with money spent managing lameness had significantly lower treatment (£2.94 PEPY) and overall (£5.00 PEPY) costs than dissatisfied farmers (£5.50 and £7.60 PEPY respectively).

If the farmers in this study adopted best practice of parenteral antibiotic treatment with no routine foot trimming, and minimised footbathing to treating/preventing interdigital dermatitis, the financial benefits would be approximately £4.65 PEPY. If these costs are similar on other farms the management changes would lead to significant economic benefits for the sheep industry.

Keywords: Sheep; Footrot; Lameness; Financial costs; Management practices

Introduction

Footrot is an infectious bacterial disease of sheep caused by *Dichelobacter nodosus*. Clinical presentation is interdigital dermatitis (ID) alone, or severe footrot (SFR) with various degrees of separation of hoof horn from the sensitive tissue; both conditions cause lameness. In England, the majority of ovine lameness is attributed to footrot (Kaler and Green, 2008; Winter et al., 2015). English farmers manage footrot using whole-flock strategies (quarantine, foot trimming, footbathing, vaccination) and individual treatments; using one or more of foot trimming, topical disinfectant and systemic antibiotic injection (Winter et al., 2015).

Routine foot trimming can cause damage to sensitive tissue, which is associated with a higher prevalence of lameness (Winter et al., 2015). Footbathing is generally associated with higher prevalence of lameness (Kaler and Green, 2009; Winter et al., 2015), except when used to prevent ID (Winter et al., 2015) or when handling facilities are excellent and sheep are turned onto pasture free from sheep for at least 2 weeks (Wassink et al., 2003, 2004). In past observational studies, vaccination was not significantly associated with prevalence of lameness (Wassink et al., 2004; Kaler and Green, 2009) but in a recent, 2013, study it was associated with a 20% reduction (Winter et al., 2015).

Footrot is one of the top five economically important diseases of sheep globally. In the UK footrot costs the sheep industry £24 - £80 million[1] per annum (Nieuwhof and Bishop, 2005; Wassink et al., 2010b). Economic losses from lameness occur in ewes left untreated for one week (Wassink et al., 2010b). Losses arise from ewe deaths and infertility (Stewart et al., 1984; Marshall et al., 1991; Nieuwhof et al., 2008), reduced numbers of lambs born and surviving, and reduced lamb growth rates (Wassink et al., 2010b).

[1] £1 GBP = approx. €1.268 and $1.433 USD on 21st April 2016. See: Reuters, http://uk.reuters.com/business/currencies (accessed 21/04/2016)

In 2006, 265 English farmers were asked whether they were satisfied with their management of lameness; 162 responded (Wassink et al., 2010a). Among ‘very satisfied’ farmers, the annual prevalence of lameness was ≤5%. Those farmers were significantly more likely to catch and treat lame sheep within 3 days and to treat sheep with footrot with parenteral and topical antibacterial products which leads to rapid recovery (Kaler et al., 2010a; Kaler et al., 2012; Strobel et al., 2014); although most farmers were also therapeutically trimming the foot, which reduces the rate of recovery (Kaler et al., 2010a).

Farmers dissatisfied with their management of lameness had a median lameness prevalence of 9.8%; dissatisfaction was associated with vaccination and routine footbathing (Wassink et al., 2010a). Dissatisfied farmers indicated that they were interested in changing their management (Wassink et al., 2010a), but also reported footbathing and vaccination as strategies they would like to use more. Additionally, it has been suggested anecdotally that individually treating lame sheep is costly in time to catch individual ewes and in medicines used, which may outweigh the benefits of treatment (King, 2013).

To date, no investigation has been done on the costs of footrot by different management strategies. In this analysis we use further data from the 162 farmers who responded to the 2006 questionnaire (Wassink et al., 2010a) and the University of Reading cost calculator model for footrot,[2] to estimate treatment costs and production losses. The model’s calculations are based on the best available evidence and expert opinion on costs and economic losses.[2] The overall costs per ewe per year (PEPY) by flock were used to investigate the relative cost-benefit of different methods for managing lameness.

[2] See: Farm Health Planning models: Calculating the costs and benefits of controlling disease, http://www.fhpmodels.reading.ac.uk/index.htm (accessed 22/07/2013)

Materials and Methods

Questionnaire design and administration

A questionnaire, described previously (Wassink et al., 2010a), was sent in 2006 to all 265 farmers who participated in Kaler and Green (2008) and indicated willingness to participate in further research. Data were entered into Excel 2003 and analysed in Minitab 17 (Minitab Ltd, UK) and Stata 13.0 (StataCorp, USA).

Management of lameness

Farmers were provided with a semi-closed list of whole-flock and individual methods for managing and treating lameness (Tables 2 and 3) and asked their frequency of doing each procedure and how long they took on each occasion.

Farmer satisfaction with their management of lameness

Farmers were asked how satisfied they were with their overall management of lameness on a 5-point Likert scale of 'very satisfied', 'satisfied', 'neither satisfied nor dissatisfied', 'unsatisfied', 'very unsatisfied', with an option of 'don't know'; and whether the methods they used to manage lameness made the best use of their time and money on a 3-point scale of 'yes', 'to some extent', 'no'. Kruskal-Wallis tests were used to investigate associations between time spent managing lameness, farmer satisfaction (overall, with use of time, with use of money) and prevalence of lameness. Box plots were visually assessed to establish that the distribution of the data met the assumptions of this test.

Production and treatment costs by farmer satisfaction, prevalence of lameness and management of lameness

The Farm Health Planning footrot calculator developed by Reading University[2] was used to calculate treatment and production costs of lameness PEPY. Forty-six of 162 flocks were excluded because of missing data.

The following data for each flock were put into the calculator: flock size, prevalence of lame ewes, time taken to treat individual sheep, and the frequency and time taken to vaccinate, foot trim and footbath the entire flock. The recovery rate for interventions was set at 50% for flock footbathing and isolation of lame sheep[2]; 20% for therapeutic foot trimming and 98% for individual clinical treatment (Kaler et al., 2010a). All other values involved in the calculations were left as the program default values; based on studies by Green et al. (2007), Wassink et al. (2003), Wassink et al. (2010b) and expert opinion[2] where there was no scientific evidence available (Table 1). "Prompt individual treatment" was defined as treatment within one week of observing a lame sheep and this option on the calculator was selected where appropriate. Farmer time was costed at the 2010 Craft grade rate[3] (£8.15). All cost variables in the model from 2011 were similar in 2016; drug prices vary considerably but the median is similar to 2011,[4] a cull ewe value was £79.48 on 09/04/2016[5] versus £80.00 in 2011 (Table 1), finished lamb values fluctuated around £60/head 2015-2016 and store lamb prices[5] and NFSCo charges (H. Davies, personal communication) were also similar to 2011, therefore these were not adjusted.

Flocks were categorised by period prevalence of lameness into <5%, 5-<10%, ≥10% as in Wassink et al. (2010a), and costs of treatment and production losses attributed to footrot PEPY were calculated for each group. Overall cost, treatment cost and production cost of footrot PEPY and prevalence of lameness were calculated by farmer satisfaction with use of money and compared using Kruskal-Wallis tests.

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[3] See: Agricultural wages order 2010, http://webarchive.nationalarchives.gov.uk/20130822084033/http://archive.defra.gov.uk/foodfarm/farmmanage/working/agwages/documents/awo10.pdf (accessed 22/07/2013)
[4] See: Farmacy, http://www.farmacy.co.uk/ (accessed 26/04/2016); VioVet, http://www.viovet.co.uk/ (accessed 26/04/2016); Wern Vets http://www.wernvets.co.uk/ (accessed 26/04/2016)
[5] See: AHDB Beef & Lamb Market Reports, http://beefandlamb.ahdb.org.uk/markets/auction-market-reports/weekly-gb-regional-averages/ (accessed 26/04/2016)

A linear regression model (Dohoo et al., 2003) was used to estimate univariable and multivariable associations between the log overall cost of lameness PEPY from the Reading calculator and management practices. Explanatory variables tested were isolating, moving, catching and foot trimming individual lame sheep; treatment with parenteral or topical antibiotics, a painkiller or vaccination; and for the whole flock, footbathing, foot trimming, vaccination and moving the flock.

A manual forward selection process (Dohoo et al., 2003) was used to test variables in a multivariable model and explanatory variables were considered significant when 95% confidence intervals did not include unity (Wald's test for significance) and were retained in the model (Cox and Wermuth, 1996). Where multi-collinearity was present, the most biologically plausible variable was included in the multivariable model. Model fit was assessed using plots of the standardised residuals against the predicted values.

Results

Response rate and descriptive statistics

There were 162/265 (61%) useable responses; not all farmers answered all questions. Median flock size was 275 ewes (inter-quartile range [IQR] 120-550) and median period prevalence of lameness was 5% (IQR 4-10, range 0-60). Prevalence of lameness did not vary significantly by flock size (P=0.3).

Management of lameness

The most common whole-flock management procedures were footbathing, routine foot trimming and moving sheep for treatment (Table 2). Foot trimming was the most time consuming activity (Table 2). The most common treatments for individual lame sheep were therapeutic foot trimming, topical antibiotic spray and antibiotic injection (Table 3).

Frequency of flock inspections for lameness

As the frequency at which farmers checked their sheep for lameness decreased, the time spent inspecting each ewe per occasion increased, but the overall amount of time spent checking ewes decreased (Table 4). Prevalence of lameness was not significantly associated with time spent checking each ewe (P=0.7), time spent checking the flock (P=0.4) or the frequency of checks (P=0.1), although farmers who checked sheep once each week had a median of 8% lameness compared to 5% in all other groups.

Farmer satisfaction with time spent managing lameness and actual time spent per ewe

One hundred and sixteen farmers answered questions on satisfaction with management of lameness. Seventy-five of 116 (64%) farmers were 'satisfied' or 'very satisfied' with overall management of lameness in ewes and 53/116 (46%) farmers considered that their methods for managing lameness made best use of their time (Table 5). The median prevalence of lameness was lower when farmers were satisfied with use of time managing lameness compared with farmers who were satisfied 'to some extent' or 'not satisfied'. Satisfied farmers spent significantly less time managing lameness than farmers who were not satisfied (Table 5).

Farmer satisfaction with money spent managing lameness and actual cost per ewe

Forty-eight of 116 (41%) farmers thought that their methods for managing lameness made best use of their money and 48/116 (41%) did 'to some extent'. Overall costs significantly increased with lameness prevalence; treatment costs increased as prevalence of lameness increased from <5% to ≥10% but this was not statistically significant (Table 6). Farmers satisfied with use of money spent on lameness had significantly lower treatment and overall costs than farmers dissatisfied with use of money (Table 7).

Management strategies associated with the cost of lameness

In the multivariable model (Table 8) parenteral antibiotic treatment of individual lame sheep was associated with a £0.79 (95% CI: £0.18-1.29) reduction in overall cost of lameness PEPY. Routine footbathing (£0.90, 95% CI: £0.08-1.90), routine foot trimming (£2.96, 95% CI: £1.77-4.43%) and vaccination (£1.19, 95% CI: £0.05-2.69) were associated with a significant increase in cost PEPY. Parenteral and topical antibiotic treatments and foot trimming individual lame sheep were positively correlated with each other, and with catching lame sheep for treatment (Supplementary Table 1). Vaccination of individual lame sheep was strongly positively correlated with vaccination of the whole flock. The model fit was good (Fig. 1).

Discussion

The key findings are that overall costs of lameness PEPY were significantly lower in flocks in the study that were following the evidence-based best managements for minimising the prevalence of lameness in sheep; prompt treatment of ewes with parenteral and topical antibiotics (Kaler et al., 2010a; Wassink et al., 2010b) and avoiding whole-flock foot trimming and routine footbathing (Wassink et al., 2003; Kaler and Green, 2009; Winter et al., 2015).

There was a net financial benefit (£0.79 PEPY) of managing lameness by treating individual lame ewes with parenteral antibiotics compared with not using this treatment, despite farmers' anecdotal concerns (King, 2013). Prompt parenteral antibiotic treatment is therefore not only the best method for reducing the prevalence of lameness (Wassink et al., 2010b), it was also the most cost-effective strategy for management of lameness across the 116 flocks in this analysis.

Routine foot trimming and footbathing cost farmers an additional £3.86 PEPY, with no reduction in prevalence of lameness. Whilst this averaged cost must be interpreted with caution because of the variability in costs between farms, it highlights that significant savings could be made if farmers stopped using ineffective whole-flock managements. The farmers in this study would save £2.96 PEPY if they stopped routine foot trimming (Wassink et al., 2003; Kaler and Green, 2009; Winter et al., 2015) and £0.90 PEPY if they stopped much routine footbathing (Wassink et al., 2003; Kaler and Green, 2009; Winter et al., 2015) and only footbathed to prevent or treat ID, which is associated with a lower prevalence of lameness (Kaler and Green, 2009; King, 2013; Winter et al., 2015).

Most farmers in this study using therapeutic antibiotic treatment were also foot trimming. Kaler et al. (2010a) reported that therapeutic foot trimming in conjunction with antibiotic treatment halves the rate of recovery. Foot trimming also leads to repeated episodes of footrot, and poor foot conformation (Kaler et al., 2010b). Farmers in the current study who did not use therapeutic foot trimming saved 4 minutes per ewe treated (Table 3), and therefore saved money. Therefore, if all the farmers stopped therapeutic foot trimming they would have saved money and reduced the prevalence of lameness in their flock.

There was no association between vaccination and the prevalence of lameness in these flocks (Wassink et al., 2010a); consequently, because of costs to purchase and administer vaccines it was a cost in these flocks. The 13% of farmers who vaccinated their sheep appeared aware of this, and did not consider vaccination effective or made best use of money (Wassink et al., 2010a). In a recent study vaccination against footrot was associated with an average 20% reduction in prevalence of lameness (Winter et al., 2015), therefore it may be of use in some flocks, for example those with high prevalence of lameness.

The higher overall costs of lameness in flocks with ≥10% prevalence, compared with <5% lameness, were mainly attributable to increased production losses, although inefficient treatment may have contributed to costs on some farms as discussed previously. Production losses arise when ewes are lame for >6 days, and are therefore lowest in flocks where ewes are treated promptly (Wassink et al., 2010b).

This is the largest study of the economics of treatment of lameness to date. Despite this, 116 is a relatively small sample and therefore there is limited power to the study and a risk of failing to detect true differences. There was a non-significant dose-response effect with treatment costs PEPY increasing as prevalence of lameness increased (Table 6). This may have been significant with a larger sample size than the 116 farms in this study; however, there was wide variation in treatment costs across all farms. This is probably a true reflection of the variability in treatment costs because we would expect the large variability to remain with a larger sample size. This is because some flocks with low prevalence of lameness have few sheep that become lame and therefore incur minimal treatment costs, whilst other flocks with low prevalence of lameness will be controlling lameness by treating sheep promptly and therefore will incur higher costs. Similarly, flocks with high prevalence of lameness will have low treatment costs if farmers rarely treat lame sheep, and others will have high costs if they waste time and money using ineffective practices such as routine foot trimming. The limited sample size may also have contributed to the non-significance observed for some cost-benefit estimates in Table 8 (treatment of individual lame sheep with topical antibiotics, painkillers or therapeutic foot trimming; catching, moving or isolating lame sheep, or moving the whole flock); potentially increasing the chance that estimates of the real effect would not be statistically significant.

In the current study, the net benefit of prompt parenteral antibiotic treatment of lame ewes was £0.79 per ewe across 116 flocks with IQR 4-10% lameness, whilst in Wassink et al., (2010b) the benefit was £6 per ewe in a within-flock comparison of a group with 2% versus a group with 6-8% lameness. The current study is far less controlled than the within-flock comparison of Wassink et al. (2010b) which creates greater random error; however, it does compare 116 farms. The smaller difference in overall cost-benefit of using parenteral antibiotics in the current study might be attributable to a higher prevalence of lameness in the lowest category of lameness (up to 5%), and so greater treatment costs and less difference between the prevalence of lameness in the flocks compared. In addition, most farmers in the current study practised therapeutic foot trimming, which delays recovery (Kaler et al., 2010a) and routine foot trimming and footbathing, which cost time and might increase lameness. In the footrot calculator these procedures are credited as benefitting sheep; this is clearly not the case (Wassink et al., 2003, 2004; Kaler and Green, 2008; Winter et al., 2015) and therefore the cost-benefit of these interventions will have been overestimated in the current study. Routine and therapeutic foot trimming and footbathing were not done during the Wassink et al. (2010b) study, and so less time, and therefore money, was spent on these unnecessary activities. Wassink et al. (2010) also classed treatment as “prompt” at <3 days, versus <1 week in the current study. The financial benefit of parenteral antibiotic treatment is probably higher if treatment is given sooner because of the reduction in onward transmission of disease; unfortunately, we did not have the data to investigate this.

The data for the current study were collected in 2007 and it is unlikely that the time taken for a management practice has changed since then. Medicines and management costs are still at similar prices to 2011, when the cost calculator was developed. Finished and cull ewe prices fluctuate widely but 2016 prices are very similar to 2011 e.g. £79.48 versus £80.00 for a cull ewe. Farmer time is notoriously difficult to cost but the cost used was that determined by the 2010 Craft grade rate. As a general rule, if the market price of lamb increases above £60/head the cost calculator estimate for production losses from incorrect treatment increase.

This study is the largest investigation of costs and benefits for management of lameness in English flocks to date. Previous analyses were based on a single-flock (Wassink et al., 2010b) and a simulation model (Nieuwhof and Bishop, 2005). One question that arises is whether the results are generalizable to all English lowland flocks. The original selection of farmers came from a random selection of farmers in the AHDB Beef & Lamb Better Returns programme. This consists of 18,000 English sheep farmers and is the most comprehensive list of sheep farmers that can be accessed. This is the same list used for 50% of participants in the 2013 questionnaire (Winter et al., 2015), the remaining 50% were sourced from a complete list of sheep farmers held by DEFRA. There was no measurable difference in sheep farmers sourced from DEFRA or AHDB by prevalence of lameness, response rate or managements investigated (unpublished data). When considering the respondents, the response rate was 61%, similar to other studies involving second questionnaires to compliant farmers (Wassink et al., 2003; Kaler and Green, 2008). The median prevalence of lameness was 5%, similar to estimates in 2004 and 2011 (Kaler and Green, 2008; King, 2013). The flock size in this study (median 275, IQR 120-550) was similar to the average flock size in 2006 of 327 ewes (Rural Business Research, 2007) and there was considerable overlap with flock size IQRs from other random studies (Kaler and Green, 2008; King, 2013; Winter et al., 2015). Management practices i.e. using “best practice” (O'Kane et al., 2016) of prompt parenteral and topical antibiotic are also similar to those in a recent study of a random sample of farmers (Winter et al., 2015). The number of farmers using footbathing as treatment for footrot has fallen to 36% since 2006 (Winter et al., 2015), possibly a result of promotion of alternative effective management practices. Therefore, as far as it is possible to ascertain, the farmers in the current study are largely similar to other farmers who have contributed to research on ovine lameness in England. It is not possible to know if the farmers in this study, or any of the other studies listed, are representative of all sheep flocks because those who do not reply to a questionnaire are unknown. However, over the past ten years the prevalence of lameness has halved (Winter et al., 2015) using results from these studies to inform farmers of the best management strategies. The main comparison in the current study is the relative difference in costs by different management strategies between flocks; this calculation does not require a population-based sample. Consequently, even if the flocks in the study are not representative of all sheep flocks, the estimated differences in costs by management strategy are expected to be similar for other lowland farms in England.

Conclusions

We conclude that for the farmers in the current study there was a net financial benefit of £0.79 PEPY from using prompt antibiotic treatment, predominantly because of lower production losses. If these farmers also stopped therapeutic foot trimming, the financial benefit would be higher. Routine foot trimming and footbathing, previously associated with higher prevalence of lameness, were associated with increased costs of lameness; £2.96 and £0.90 respectively. If these farmers stopped these practices they would save a further average of £3.86 PEPY. If the costs in the current study are similar for other sheep flocks in England, these results indicate that adopting best practice to treat and control footrot would benefit the health of sheep and the economics of sheep farming.

Conflict of interests

The authors have no conflict of interests.

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Appendix: Supplementary material

Supplementary data associated with this article can be found, in the online version, at doi: ... (Supplementary Table 1)

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Tables and Figures

Table 1

Assumptions used in the University of Reading footrot calculator.

Flock and footrot details	Assumed value
Expected lambing percentage (at scanning)	150%
Percentage lambs sold as finished	25%
Percentage of ewes with footrot culled	3%
Average finished lamb value	£60/head
Average store lamb value	£40/head
Average cull ewe value	£80/head
National Fallen Stock Company (NFSCo) charges	£20/head
Treatment	**Cost per ewe**
Individual clinical treatment (parenteral antibiotic)	£1.30
Isolation of clinical case	£1.00
Chemical cost of flock footbathing	£0.10
Vaccination product cost (per dose, per ewe)	£0.80
Cost of routine flock foot trim	£1.30
Response to treatment	**Response rate**
Prompt individual clinical treatment (parenteral antibiotic)	98%
Isolation of clinical case	50%
Flock footbathing	50%
Routine foot trimming of all sheep	20%
Effects of disease on ewes	**Percentage reduction**
Dry ewe conception rate	15%
Dry ewe condition	15%
Dry ewe survival	2%
Pregnant ewe condition	15%
Pregnant ewe survival	5%
Lactating ewe condition	15%
Lactating ewe survival	5%
Lambing percentage	15%
Lamb survival	12%
Number of finished lambs	15%

Table 2

Whole-flock management practices used by 162 English farmers in 2006.

Flock management	Minutes per ewe		Frequency of management, per year		Hours, per 100 ewes, per year		Number (%) farmers using management
	Median	IQR [a]	Median	IQR	Median	IQR	
Routine foot trim	4.2	2.5-7.5	2.0	1.0-2.0	11.2	5.7-24.7	80 (49)
Footbath	1.0	0.6-1.8	4.0	2.0-9.0	6.2	3.3-17.9	92 (57)
Vaccine	1.1	0.6-2.0	1.0	1.0-1.0	1.8	1.0-4.7	21 (13)
Move to treatment area	0.5	0.2-1.3	3.5	2.0-9.5	3.4	1.0-8.1	71 (44)

[a] IQR = interquartile range

Table 3

Number and percentage of 162 English Sheep farmers using different methods to treat footrot in individual lame ewes, and the median time per activity, in 2006.

Management practice	Minutes per activity, per ewe		Number (%) farmers using this management
	Median	IQR [a]	
Move to treatment area	10	2-15	51 (31)
Isolate ewe	5	2-10	5 (3)
Therapeutic foot trim	4	2-5	136 (84)
Catch ewe	2	1-5	128 (79)
Footbath	1	1-5	89 (55)
Vaccinate	1	1-3	20 (12)
Antibiotic spray	1	1-2	131 (81)
Antibiotic injection	1	1-2	101 (62)

[a] IQR = interquartile range

Table 4

Frequency of, and time spent, checking sheep for lameness by 162 English farmers.

Frequency of inspections	Number (%) farmers	Minutes spent per ewe, per inspection		Minutes spent per ewe, per week	
		Median	IQR [a]	Median	IQR
Everyday	87 (53.7)	0.28	0.15-0.50	1.93	1.05-3.50
Twice a week	19 (11.7)	0.33	0.18-1.17	0.66	0.35-1.50
Once a week	26 (16.0)	0.48	0.31-1.38	0.48	0.31-1.38
< Once a week	27 (16.7)	0.29	0.00-0.60	0.09	0.00-0.18
Kruskal Wallis test		P=0.02		P<0.01	

[a] IQR = interquartile range

Table 5

The median management time per ewe per year (PEPY) and prevalence of lameness for flocks grouped by farmer ratings of overall satisfaction and satisfaction with use of time.

Satisfaction	Number (%) farmers	Management hours PEPY		Prevalence of lameness	
		Median	IQR [a]	Median	IQR
Overall satisfaction					
Very Satisfied	11 (9)	2.36	0.42-3.91	3.0	2.0-10.0
Satisfied	64 (55)	1.84	0.97-3.96	5.0	3.0-7.75
Neither	25 (22)	1.90	0.94-5.22	10.0	5.0-10.0
Unsatisfied / Very Unsatisfied	16 (14)	1.20	0.58-1.81	8.5	5.0-15.0
Kruskal-Wallis test		P=0.35		P=0.01	
Satisfaction with use of time					
Satisfied	53 (46)	1.46	0.72-3.18	5.0	3.0-10.0
Satisfied to some extent / Unsatisfied	59 (51)	1.90	1.02-4.59	7.0	5.0-10.0
Kruskal-Wallis test		P=0.04		P<0.01	

[a] IQR = interquartile range

Table 6

Overall costs, treatment costs, and production losses per ewe per year (PEPY) by prevalence of lameness for 116 English sheep flocks.

Prevalence of lameness	Number (%) farmers	Overall cost PEPY (£)		Treatment cost PEPY (£)		Production losses PEPY year (£)	
		Median	IQR [a]	Median	IQR	Median	IQR
< 5	34 (29.3)	3.90	2.15-5.75	2.67	1.22-4.86	0.80	0.56-1.05
5 - < 10	44 (37.9)	5.15	2.85-7.75	3.47	1.08-6.41	1.51	1.45-1.61
≥ 10	38 (32.8)	6.35	4.95-8.38	3.68	2.04-5.30	2.40	2.23-2.87
Kruskal-Wallis test		$P<0.01$		$P=0.43$		$P<0.01$	

[a] IQR = interquartile range

Table 7

Prevalence of lameness, overall and treatment costs of footrot per ewe per year (PEPY) by farmer satisfaction with use of money

Farmer satisfaction with use of money	*n*	% Lame		Overall cost PEPY (£)		Treatment cost PEPY (£)	
		Median	IQR [a]	Median	IQR	Median	IQR
All farmers	116	5.0	4.0-10.0	5.45	3.30-7.60	3.47	1.41-5.43
Satisfied	48	5.0	3.0-10.0	5.00	2.70-7.10	2.94	0.84-5.03
Satisfied to some extent	48	6.0	4.5-10.0	4.95	3.33-6.70	2.95	1.29-4.59
Unsatisfied	6	6.0	4.25-15.0	7.60	5.48-8.78	5.50	3.00-7.83
Don't know	14	8.0	4.5-12.8	6.60	4.70-12.63	4.07	3.40-8.46
Kruskal-Wallis test		P=0.17		P=0.02		P=0.03	

[a] IQR = interquartile range

Table 8

Univariable and multivariable linear regression model of management practices associated with changes in overall cost of lameness per ewe per year (PEPY) in 116 English sheep flocks.

				Univariable				Multivariable			
Management		*n*	%	Change in cost	95% CI [a]		*P* value	Change in cost	95% CI		*P* value
Individual treatments											
Parenteral antibiotic	N [b]	39	33.6%								
	Y [c]	77	66.4%	-£0.82	-£1.41	-£0.06	0.039	-£0.79	-£1.29	-£0.18	0.015
Topical antibiotic	N	15	12.9%								
	Y	101	87.1%	-£0.86	-£1.64	+£0.26	0.123				
Foot trim	N	14	12.1%								
	Y	102	87.9%	-£0.97	-£1.74	+£0.14	0.082				
Isolate	N	95	81.9%								
	Y	21	18.1%	-£0.04	-£0.96	+£1.23	0.947				
Move	N	80	69.0%								
	Y	36	31.0%	+£0.54	-£0.38	+£1.73	0.277				
Catch	N	19	16.4%								
	Y	97	83.6%	-£0.19	-£1.10	+£1.07	0.734				
Painkiller	N	111	95.7%								
	Y	5	4.3%	-£0.24	-£1.69	+£2.39	0.817				
Vaccination	N	104	89.7%								
	Y	12	10.3%	+£2.42	+£0.54	+£5.19	0.008				
Flock management strategies											
Footbath	N	46	39.7%								
	Y	70	60.3%	+£1.70	+£0.61	+£3.07	0.001	+£0.90	+£0.08	+£1.90	0.031
Foot trim	N	46	39.7%								
	Y	70	60.3%	+£3.68	+£2.33	+£5.33	<0.001	+£2.96	+£1.77	+£4.43	<0.001
Move	N	59	50.9%								

	Y	57	49.1%	+£0.64	-£0.24	+£1.75	0.172				
Vaccination	N	98	84.5%								
	Y	18	15.5%	+£2.38	+£0.78	+£4.59	0.002	+£1.19	+£0.05	+£2.69	0.041
Lameness											
For each percentage increase				+£0.14	+£0.08	+£0.20	<0.001				

The intercept of the model was £3.47 (95% CI: £2.76-4.35, *P*<0.001). Associations significant at p≤0.05 (Wald's statistic) are shown in bold. [a] CI: confidence interval. [b] N: no. [c] Y: yes.

Figure 1

Plot of the predicted values against the standardised residuals, for the linear regression model of management practices associated with log cost of lameness