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Research paper

Familiarity with and uptake of alternative methods to control sheep gastro-intestinal parasites on farms in England

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ABSTRACT

A questionnaire was distributed electronically amongst sheep farmers in England; it aimed to provide a quantification of current anthelmintic practices, farmer awareness of the issue of anthelmintic resistance (AR) and the uptake, awareness and opinions surrounding conventional and alternative methods of nematode control. The majority of farmers relied on several anthelmintics and used faecal egg counts to identify worm problems. Although farmers were aware of the issue of AR amongst helminth parasites in the UK, there was a disconnection between such awareness and on farm problems and practice of nematode control. Grazing management was used by 52% of responders, while breeding for resistance and bioactive forages by 22 and 18% respectively. Farms with more than 500 ewes, and farmers who felt nematodes were a problem, had a higher probability of using selective breeding. Farmers who considered their wormer effective, had a qualification in agriculture and whose staff did not include any family members, were more likely to use bioactive forages; the opposite was the case if farmers dosed their lambs frequently. Amongst the alternatives, highest preference was for selective breeding and vaccination, if the latter was to become commercially available, with more respondents having a preference for breeding than actually using it. Several barriers to the uptake of an alternative were identified, the most influential factor being the cost to set it up and the length of time for which it would remain effective. The disconnection between awareness of AR and practice of nematode control on farm reinforces the need for emphasising the links between the causes of AR and the consequences of strategies to address its challenge.

1. Introduction

Gastro-intestinal nematode (GIN) parasites are the single most pervasive challenge to the health and welfare of sheep worldwide (Morgan and Coles, 2010; Domke et al., 2011), and a significant cause of economic loss to the relevant industries (Matika et al., 2011; Burgess et al., 2012). GIN infections are predominantly treated through the use of pharmaceuticals. However, an over reliance on these treatments has led to the evolution of anthelmintic resistance (AR) in GIN populations (Larsen, 2006; Papadopoulos et al., 2012). Management strategies contributing to an increased rate of AR generation have been identified, including higher drenching frequency, under dosing (Lawrence et al., 2007; Papadopoulos et al., 2012; Laurenson et al., 2013) and the previously recommended dose and move strategy (Morgan and Coles, 2010; Domke et al., 2011). Monitoring current anthelmintic protocols is therefore important to ensure that farms are using anthelmintics in a way that does not promote AR (Kahn and Woodgate, 2012).

Alternatives to control GIN, such as breeding for resistance to parasites (Bishop, 2012), targeted nutrition and bioactive forages (Coop and Kyriazakis, 2001), have been considered as means of reducing the use of anthelmintics and by extension the rate of AR development, although their uptake by the UK sheep industry is currently unknown. Previously surveys have been used to quantify the extent to which of GIN management techniques on small ruminant farms are employed, and have served as useful determinants of how well AR awareness programmes are working (Morgan and Coles, 2010). The aim of this paper was three fold: (1) to develop a survey able to build upon previous surveys of UK sheep farms (Fraser et al., 2006; Burgess et al., 2012) and give an updated quantification of anthelmintic practices used on such farms in England, identify farmer awareness of the issue of AR and whether such awareness influences helminth control strategies. (2) The survey aimed to be the first in its field to quantify responder uptake, awareness and opinions surrounding alternative methods of GIN control. This included both currently commercial available options and ones that may become available in the future, such as

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nematophagous fungi and vaccination. (3) Finally, as previous surveys have highlighted the lack of information on the best way to disseminate parasite management information to farmers (Fraser et al., 2006; Woodgate and Love, 2012), the survey also focussed on how respondents received information on GIN management and AR control.

2. Materials and methods

2.1. Study population

The population of the study consisted of sheep farmers who are registered as members of the English Beef and Lamb Executive (EBLEX) Ltd. (now Agricultural and Horticultural Development Board Beef and Lamb), and have their farms located in the south west and north east and north west of England, as these regions have the highest numbers of sheep in England (EBLEX, 2014). All 1616 EBLEX sheep farmers located in these regions were asked to complete the survey on line. Survey distribution was split between two regions due to previous surveys finding regional differences in parasite exposure (Bennema et al., 2010), AR (Burgess et al., 2012) and chemo-prophylactic use (Bloemhoff et al., 2014). The survey was incentivised through all completed surveys being entered into a prize draw to win an £100 Amazon voucher.

2.2. Questionnaire

The starting point was questions used in previous surveys that related to control of GIN in ruminants (Maingi et al., 1996; Fraser et al., 2006; Čerňanská et al., 2008; Morgan and Coles, 2010; Domke et al., 2011; Burgess et al., 2012; Morgan et al., 2012; Falzon et al., 2013). The questionnaire was piloted and internally validated on a small number of farms, allowing determination of consistency of responses and ensuring the language used within the survey could be easily understood by the target audience, and an estimation of how long the survey took to complete. After completion of the pilot survey aim, internal audit and further discussions took place, to test how accurate the responses were in terms of the quantitative data. This led to the inclusion of an extra option in the methods of communication section of the survey, that of choosing to get information from an agricultural merchant.

The final questionnaire consisted of 62 questions, divided into four sections, aimed at obtaining information on the following: section one (farm demographics), section two (anthelmintic use), section three (quarantine protocol), and section four (awareness of alternative strategies, barriers to using alternative strategies and preference of obtaining information on worm control strategies). The alternatives considered within the survey were based on reviews of possible alternative methods of GIN control research (Coop and Kyriazakis, 2001; Stear et al., 2007). Questions on the following alternatives included: grazing management (GM), breeding for resistance (BR), vaccination, bioactive forage (BF), such as chicory, birdsfoot trefoil, and sainfoin, and fungal biocontrol agents. Regarding vaccination, it was clarified in the questionnaire that currently there were no commercially available vaccines against nematodes, so the question was based on the hypothesis that this may become available in the future. For each one a question on awareness and opinion on that alternative was asked. For GM, BR and BF an additional question was asked on whether farmers used any of the methods, as all three are recommended by EBLEX. Within the survey acronyms were used for the following organisations: NADIS (National Animal Disease Information Service) and SCOPS (Sustainable Control of Parasites in Sheep). Moreover, Faecal egg count was abbreviated to FEC. Questions about quarantine procedure were based on guidelines given in EBLEX literature. This allowed us to gauge the exactness of whether farms were implementing their quarantine procedure correctly, rather than eliciting just a simple yes or no answer to whether they quarantined their animals or not.

Table 1
Dependent variables for each of the four binary and the two multinomial models regression created for the Parasite management survey response dataset.

	Variable categories
Binary models	
Genetics use	Yes
	No
Bioactive forage use	Yes
	No
Resistance status of anthelmintic products used	Using 2 or more high resistance anthelmintics
	Using 1 or 0 high resistance anthelmintics (see Table 1c)
Farmer felt anthelmintic be ineffective	Yes
	No
Multi nominal models	
Number of types of anthelmintics used on farm	1
	2
	3
	4
Number of alternatives farmers are aware of	1
	2
	3
	4
	5
	6

The questionnaire consisted of binary and multiple choice questions, with some questions providing a comment box for recipients to write their own responses to questions. Farmers that were contacted were given one month to complete the survey.

2.3. Statistical analysis

'Google Forms' software was used to create the online survey, making the survey available through the link provided in the distribution email. 'Google Forms' was automated to collate all answers into a 'Google spreadsheet' which could then be downloaded into a 2010 Microsoft Excel spreadsheet for statistical analysis. Most descriptive statistics were automatically produced by 'Google Forms' software; there being a constant live update of results in graphs and pie charts.

Survey responses were then imported into RStudio software (R version 2.15.1) where further analysis could be undertaken. Analysis was carried out on data relating to use of alternative strategies and use, and perception of anthelmintic protocols. Four binary and two multi nominal regression models of association were created, as shown in Table 1. Categorization of resistance of anthelmintics used on farm was according to McMahon et al. (2013).

Chi squared analysis was first carried out between all independent variables within the dataset with the function *chisq test* of the R package *stats*. A full list of variables classed as independent and used for the multinomial and binary models are listed in Table 2. When two variables were highly correlated in the Chi square test ($p < 0.001$) the variable not significant in the univariate analysis was removed from subsequent models to avoid confounding effects. If both variables were significant, the one judged susceptible to give the most interesting outcome for the study was kept. Subsequently, the function *glm* from the R package was used for the formation of binary models. Only univariate models giving a p value <0.25 were used within the formation of the multivariate analysis. Final models