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Factors likely to influence the adoption of targeted selective treatment strategies by sheep farmers in Western Australia

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ABSTRACT

The investigation aimed to assess factors affecting the uptake of novel targeted selective treatment (TST) strategies by sheep farmers in Western Australia where the most common nematode species present were *Teladosagia circumcincta*, *Trichostrongylus* spp. and *Nematodirus* spp. ("scour worms"). The study used a questionnaire format with questions concentrated on current worm control practices and farmers' current understanding and adoption of putative TST strategies. Participants represented a range of environments (derived from four farming regions) and sheep management situations, and it is therefore likely that the results of this investigation will apply in other locations where scour worms predominate. Sixty-five percent of participants were aware of the TST concept and 25% had implemented it in some form. The awareness of the TST approach was greatest where sheep farmers were concerned about anthelmintic resistance, where tools such as worm egg counts and faecal worm egg count resistance tests were employed, and where professional advisers were consulted regarding worm control. Respondents that sought advice chiefly from rural merchandise retailers were considerably less (0.1–0.6 times) likely to be aware of these management tools or to be aware of TST approaches. The findings indicated that the adoption of TST strategies will require greater use of professional advisers for worm control advice by sheep farmers, and that advisers are conversant with TST concepts.

1. Introduction

Resistance by sheep nematodes to anthelmintics (drenches) is a major problem for sheep industries globally (Kaplan and Vidyshankar, 2012). Factors including nematode biology, environment, and sheep management affect the occurrence of anthelmintic resistance, and the rate at which anthelmintic resistance develops depends on the selection pressure exerted by these factors to favour resistant genes in the nematode population (Kaplan, 2010).

A key concept in the management of anthelmintic resistance is the provision of "refugia" for a population of parasites not exposed to anthelmintic treatment, thus serving to dilute resistant individuals surviving anthelmintics so they do not become a significant part of the total population (Van Wyk, 2001). Parasite control strategies that maintain significant levels of refugia by limiting exposure of parasites to treatments aim to decrease the development of resistance by reducing the frequency of resistant genes in the parasite population (Kenyon et al., 2009; Leathwick et al., 2009; Leathwick and Besier, 2014). However, in some situations even relatively infrequent anthelmintic treatments are associated with a high resistance prevalence, due to environmental or animal management factors (Besier and Love, 2003; Leathwick and Besier, 2014). Targeted Selective Treatment (TST) is a refugia-based approach to worm control that restricts anthelmintic treatment to animals judged likely to suffer significant production loss or health effects if not treated, while avoiding treatment for individuals less likely to benefit from the treatment (Kenyon et al., 2009; Leathwick et al., 2009; Besier, 2012; Kenyon and Jackson, 2012). However, apart from the FAMACHA system, that identifies individual animals in need of treatment against *Haemonchus contortus* from an indication of anaemia based on the conjunctival membrane colour, according to a standardised colour chart (Van Wyk and Bath, 2002), TST strategies largely remain at a validation stage and there are few examples where the concept has been translated into practicable recommendations for non-haematophagous species (Cabaret et al., 2009; Besier, 2012).

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Sustainable worm control strategies are essential in sheep producing environments such as the Mediterranean climatic regions of Western Australia (WA) where a high prevalence of anthelmintic resistance is associated with the heavy selection pressure imposed by commonly-used summer treatment strategies (Besier and Love, 2003). Alternative strategies based on refugia principles have been developed (Woodgate and Besier, 2010), but the need for significant changes to traditional control programs are believed to explain limited adoption of the modified strategies to date (Besier, 2012). In this context, the relative simplicity of TST-based programs may be considered by sheep farmers to be more practicable, with consequent greater uptake and adoption. However, local anecdotal information suggests that many farmers find it difficult to accept the concept of deliberately withholding anthelmintics to a proportion of sheep because it appears counter to long-held views that effectiveness of drenching may be compromised unless all animals in the flock are treated. Whether this reflects a lack of awareness or acceptance that anthelmintic resistance is a significant constraint on sheep productivity, and therefore the need for more sustainable control practices, is not clear. A recent national survey by the Sheep Cooperative Research Centre (M. Curnow, unpublished) indicated that whilst some practices recommended as elements of sustainable worm control programs, including use of worm egg counting (WEC) as the basis of drenching decisions, have been well-adopted, other practices such as faecal worm egg count reduction tests (FWECRT) to assess anthelmintic efficacy, have not. There is consequently a need to investigate factors likely to influence the likely uptake (or otherwise) of TST and other sustainable practices as the basis of efforts to promote wider adoption.

This investigation aimed to identify factors associated with the acceptance of sustainable worm control practices, especially those likely to facilitate the adoption of TST strategies by farmers in Western Australia, as the strategies may initially appear counter intuitive to farmers. More specifically, the study aimed to determine whether farmer demographics, current worm control practices and sources of animal health advice are likely to impact the awareness of TST strategies and attitudes towards adoption. The results of this investigation will act as the basis for the development of communication strategies of TST to farmers, which can be varied appropriately to suit the complexity of such strategies as suggested by Woodgate and Love (2012).

2. Materials and methods

2.1. Study design

The study conforms to the international reporting guidelines for strengthening the reporting of observational studies in epidemiology (STROBE) (von Elm et al., 2008) and was approved by the Murdoch University Human Research Committee.

The study used a questionnaire that could be completed using a paper format or in a personal interview. The questionnaire included 14 short-answer questions, four of which included specific options from which respondents could select an answer, and five of which required Yes/No answers. Questions focussed on farmer demographics included age of the respondent(s), farm location, farm size, area cropped and number of sheep. Questions focused on current worm control practices included examined respondent utilisation use of WEC and FWECRT for treatment decisions, timing and the number of drenches given in the past year to adult ewes, sources of worm control advice and perception of severity of drench resistance in their district. Questions focussed specifically on TST examined their current understanding and adoption of putative TST strategies. For this purpose, participants were asked whether they were aware of or had implemented strategies whereby some sheep were deliberately left untreated when a flock treatment was given, and whether they would consider implementing TST strategies in the future.

Colleagues from Murdoch University's School of Veterinary and Life Sciences and the state department of agriculture were recruited for pre-testing during the development of the questionnaire to ensure questions were clear and unambiguous with no bias. Modifications to question design were made in response to feedback.

2.2. Data collection

Data were obtained from 106 sheep farmers that were individually recruited to participate in the survey at five different field days throughout regional WA, from July to September 2012, giving a sample of respondents equivalent to a focus group.

Farmers were approached at random at the field days where the interviewer explained the purpose of study and invited the farmer to participate in the survey. To be eligible for the study, participants needed to be commercial sheep producers (running more than 200 sheep, for a commercial income) within the major sheep producing regions of Western Australia. Following recruitment, questionnaires were completed either in a short interview ($n = 72$) or by the farmer in written format ($n = 34$) and returned to organisers. The questionnaire was identical in both formats and responses from both formats (written or interview response) and all five field days were analysed together.

All responses were collected from farmers in regions in Western Australia where the major worm species of clinical significance were *Teladosagia circumcincta*, *Trichostrongylus* spp. and *Nematodirus* spp., with *H. contortus* absent or only occasionally of significance (Woodgate and Besier, 2010). No follow up was required.

The validity of the size of the final study group was assessed following recruitment of 106 respondents at the five field days to confirm that the geographical distribution of respondents was approximately representative of the distribution of sheep in Western Australia and that statistical differentiation between the relative importance of factors included in the questionnaire could be achieved.

2.3. Statistical analysis

Data analyses were conducted using the software SPSS Statistics Standard Version 22.0 (IBM Corporation, Armonk NY). The experimental unit was respondent (farmer). There was no non-response as all farmers recruited to the focus group completed the questionnaire.

Respondents were allocated to a region based on farm location, categorised according to agricultural regions of WA representing production areas for sheep, cattle and crops in the state (Fig. 1). Drench timing was categorised by season; summer (December–February), autumn (March–May), winter (June–August) and spring (September–November). Respondents were categorised into seven age categories. Responses from age groups <20 and >70 were excluded due to lack of responses in these groups for analyses where age category was an independent variable.

Categorical data (utilisation of WEC and FWECRT, perception of relevance of resistance in the district, awareness and adoption of TST, source of worm control advice) were analysed using Chi square analysis (two-tailed probability) to confirm statistical differences between categorical data, and odds ratios with relative risk used to quantify relationships between factors. Continuous data (for example, rainfall, farm size, area cropped, proportion of farm cropped, number of sheep and farmer age) were analysed using univariate general linear models or linear regression. Annual rainfall data was