**Title: Identifying and addressing barriers to sustainable control of roundworms in sheep**

**Application:** Farmers lack confidence in advice they receive around sustainable control of gastro-intestinal nematodes in sheep and are unwilling to change practice in case those changes have negative impacts on their businesses.

**Introduction:** Gastro-intestinal nematodes (GIN) are common, highly pathogenic parasites of sheep, especially first season grazing lambs. These parasites are traditionally controlled using routine anthelmintic treatments during the grazing season. In recent years, resistance has developed in populations of GIN to all three major anthelmintic classes and multi-drug resistant parasites have been reported on many farms in the UK. Two new anthelmintic classes were introduced in the UK in 2009 (Zolvix) and 2012 (Startect), resistance has already been reported to Zolvix (Bartley et al 2019).

To mitigate the impact of resistance on control of GINs, advice to farmers has changed and is now focussed on identifying risk, using anthelmintics when indicated e.g. by high faecal egg counts or failure to meet weight gain targets and using alternative strategies such as pasture management, mob grazing etc to reduce exposure (<https://www.scops.org.uk>). However, despite a plethora of industry messages, many farmers do not engage with these messages. The aim of this study was to identify the barriers behind this lack of engagement and, by developing a mathematical model, to demonstrate the impact of sustainable parasite control measures, on a typical farm.

**Materials and Methods:** An online questionnaire was used to provide a snapshot of management and worming practices on a cross section of sheep farms across the UK.

Focus groups were held across the UK, either in person or online between December and June 2023. Nine meetings were held, six with farmers, including some ‘seldom seen’ farmers, i.e. people who had no history of engaging with their Veterinary Practice’s knowledge exchange programmes. In addition, one group was held with farm animal veterinarians and two with suitably qualified persons/registered animal medicines advisors (SQP/RAMA). Discussions were recorded and transcribed for thematic analysis.

A mathematical model of a ‘typical’ sheep farm was developed, informed by data collected through the online questionnaire. The model parameters included growth rates of Texel cross lambs, anorexia, development of immunity, development of larvae on pasture, pre and adult worm burdens, faecal egg counts and meteorological data including rainfall and temperature. The model was evaluated using data from previous studies (Kenyon et al 2013).

**Results:** 51 usable responses were obtained from the survey. Upland, lowland and hill farms were represented. The median number of breeding ewes was 300; lambing was most common between March and April and the most common breed was Texel. Almost all farmers used anthelmintics in lambs and triggers included faecal egg counts, not thriving, scour, set interval treatments. Between one and six treatments were used per season. Most farmers set-stocked ewes and lambs until weaning and rotated lambs every 2-3 weeks thereafter.

From the farmer focus groups, there was a great feeling of uncertainty particularly around who and what advice to trust. This uncertainty prompted farmers to follow their established practice. Barriers to change were grouped into four themes:

(i) practical difficulties around labour availability, time and cost to change practice, convenience to fit worm control into current farm practice.

(ii) not seeing the need to change – current practice was perceived to work, hence ‘no need to change’,

(iii) lack of information and support, particularly considering the changing nature of sheep farming, climate etc.

(iv) a lack of faith in new methods – the advice has changed, but where is the evidence that the new advice works? Anecdotal reports of sheep dying when wormers had not been used because of negative faecal egg counts for example.

There were also positive outcomes, notably an appetite for information and knowledge, an awareness of anthelmintic resistance and its consequences, growing uptake of faecal egg counts which were proving to be beneficial to their businesses.

SQP/RAMAs and vets highlighted the importance of engaging with farmers regularly to encourage adoption of new control strategies.

The mathematical model was developed for unparasitized and parasitised lambs over a grazing season and outputs compared to data from experimentally infected lambs. Four treatment scenarios were then evaluated: (i) 4-weekly treatments from weaning to sale; (ii) treatment at weaning and 6 weeks later; (iii) treating 90% of the lambs at 4-weekly intervals; (iv) treatment based on monthly faecal egg counts. The outputs demonstrated how different sustainable worming strategies could be used to maintain growth rates of lambs.

**Conclusions:** there was a sense of shared endeavour amongst farmers, vets and SQP/RAMAs around sustainable control of GIN in sheep. Amongst farmers there was a deep sense of anxiety around leaving lambs untreated and changing their normal worming practices. Farmers were unwilling to take risks that might compromise the health and productivity of their animals, which could impact their business. To address these barriers, more evidence-based studies, both model outputs and on-farm are needed, together with bespoke educational programmes, to convince farmers to focus their efforts onto more sustainable control of GINs.

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