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Sustainable control of nematode parasites – A New Zealand perspective☆

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ABSTRACT

In many countries the presence of anthelmintic-resistant nematode parasites in sheep flocks is now the norm rather than the exception. Given this, resistance management should be an integral component of all parasite management plans. Production trials have shown a significant financial disadvantage from using an anthelmintic which has reduced efficacy due to resistance, and yet many farmers remain reluctant to test for the presence of resistant parasites.

Much progress has been made in identifying practices which select for resistance, such as treatment on low-contamination pastures, use of long-acting anthelmintics and intensive grazing of monocultures of young livestock. The identification of high-risk practices has enabled alternatives to be found or, where no practical alternative is available, steps taken to mitigate the risk. Many resistance management strategies involve the deliberate retention of susceptible worm genotypes *in refugia*, and numerous approaches to achieve this have been evaluated. A major factor in determining how much refugia is required is the efficacy of the anthelmintic administered. Treatments which achieve high efficacy require less refugia to dilute the resistant survivors, and the most effective way to achieve high efficacy is to use combinations. Utilising refugia and combination anthelmintics can significantly slow the development of resistance. In New Zealand, an array of resistance management practices is now available, with many recommendations backed by empirical studies and evaluated on commercial farms. For sheep, the future focus will increasingly become one of extension and implementation of these practices on-farm.

1. Introduction

Anthelmintic resistance is now sufficiently common throughout the world that it should be considered a major issue in the control of parasites (Kaplan and Vidyashankar, 2012; McMahon et al., 2013a) and as such an integral component of worm-control decision-making for all sheep farmers and their advisors. This applies equally in New Zealand, where more than two thirds of sheep farms have detectable levels of resistance (Waghorn et al., 2006; McKenna, 2010). Resistant worms are undoubtedly present on other farms at levels too low to be detected using available tests. Thus, in New Zealand, as in other parts of the world, the presence of resistant parasites on a farm has become the norm rather than the exception.

Effective management of anthelmintic resistance requires an understanding of the dynamics of resistance development, and achieving this requires significant scientific endeavour. Once it is understood how resistance is selected, it should be possible to modify common farming

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practices in order to reduce selection. However, without adoption and uptake by the farmer, little will be gained. Farmer interest normally requires a financial incentive, and so a clear demonstration of the potential costs of anthelmintic resistance is usually required.

The management of anthelmintic resistance, therefore, requires a broad range of skills and capabilities working collectively to deliver solutions which are not only effective but are practical enough to be acceptable to the farmer. Considerable progress has been made in understanding many of the factors selecting for and against the development of anthelmintic resistance (Barnes et al., 1995; Leathwick et al., 2009) and, importantly, many of the recommendations communicated to farmers are now supported by sound empirical evidence (e.g. Waghorn et al., 2008). Increasingly then, the challenge is moving from one of understanding how to manage anthelmintic resistance to one of ensuring that these practices are implemented on commercial farms. While there has been some success, in some countries like the UK (Abbott et al., 2012), there are regions where there has been only limited implementation of resistance management practices on-farm (e.g. McMahon et al., 2013b).

2. The economic benefit of testing for resistance

Even though anthelmintic resistance is common in many countries, there still appears to be reluctance by farmers to undertake resistance testing on their farms. The result is that the proportion of farmers testing for resistance is often much lower than the proportion of farms on which resistance is present (Lawrence et al., 2007; McMahon et al., 2013a). Inevitably then, many farmers are using anthelmintics without any real knowledge of their effectiveness, and undetected production losses are undoubtedly occurring. In New Zealand, the perception is common that if there are no visual signs of parasitism in the stock then everything is working as expected i.e. farmers think they will see a resistance problem as signs of parasitism in their animals.

Recent production trials have shown that subclinical parasitism associated with the use of an anthelmintic for which efficacy is compromised by resistance can equate to 10–14% loss of carcass value (Sutherland et al., 2010; Miller et al., 2012). At the time these trials were conducted the losses amounted to approximately NZ$ 10–15/lamb. In contrast, on a farm finishing 5000 lambs annually, a comprehensive efficacy test every 3 years would cost approximately 10c/lamb. These figures show that despite no obvious visual signs of parasitism the cost of anthelmintic resistance can far out-weigh the cost of testing.

3. New anthelmintic actives

Two new anthelmintic classes have recently been launched for use in sheep. Monepantel, a member of the amino-acetonitrile derivative (AAD) class (Kaminsky et al., 2008) and derquantel, a spiroindole (Little et al., 2010) were first released in New Zealand in 2009 and 2010, respectively. The availability of these new classes has to an extent removed the risk of farmers being unable to control resistant parasites using anthelmintics. However, given the price premium on these products, there remains a significant cost benefit to retaining, where it is still possible, the effectiveness of the older, cheaper, anthelmintics. In addition, it is equally important that these new actives are used in such a way as to preserve their usefulness for as long as possible (Besier, 2007).

In New Zealand, a strategy has been developed where a single treatment with a new active, as part of a structured programme of preventive treatments to lambs, has the potential to slow the emergence of resistance to the older anthelmintic classes (Leathwick and Hosking, 2009). Normal practice in New Zealand is to administer 5–7 treatments to lambs at 28–30 day intervals (Lawrence et al., 2007) over summer-early autumn. This programme was designed on the basis of epidemiological knowledge to minimise the contamination of pastures in the autumn (Vlassoff et al., 2001). Because adult worms often live much longer than the 28–30-day drenching interval, resistant survivors can accumulate over the course of this programme. A single treatment with a highly effective anthelmintic at the beginning of autumn should prevent these accumulated resistant worms from passing eggs onto pasture at a time when conditions are highly favourable for development to the infective larval stage (Leathwick and Hosking, 2009) and minimise their contribution to future generations of worms. This practice has been widely promoted in New Zealand and has been adopted by a proportion of farmers.

4. Minimising the development of resistance

Over the last 3 decades considerable progress has been made in understanding the dynamics and management of anthelmintic resistance (Smith, 1990; Barnes et al., 1995; Leathwick et al., 2009). Importantly, many of the resistance management strategies being recommended today are now supported by empirical studies (Leathwick et al., 2006; Waghorn et al., 2008; Leathwick et al., 2012; Kenyon et al., 2013). In general, resistance management strategies fall within three broad categories;

- Identify and mitigate high risk practices
- Maintain 'refugia' of susceptibility
- Use combinations of effective anthelmintics

5. Identifying high risk practices

The identification of management practices which are likely to result in a rapid increase in the prevalence of resistant genotypes is important for several reasons. Firstly, once a practice is recognised as being inherently high-risk then alternative approaches can be sought i.e. its use may be eliminated completely. Alternatively, if no practical alternative to achieving the same production goals is available, then steps may be taken to negate or minimise the associated risk, i.e. the practice may be modified to reduce the risk. Practices identified as being highly selective for resistance include: