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The management of anthelmintic resistance in grazing ruminants in Australasia—Strategies and experiences

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ABSTRACT

In many countries the presence of anthelmintic resistance in nematodes of small ruminants, and in some cases also in those infecting cattle and horses, has become the status quo rather than the exception. It is clear that consideration of anthelmintic resistance, and its management, should be an integral component of anthelmintic use regardless of country or host species.

Many years of research into understanding the development and management of anthelmintic resistance in nematodes of small ruminants has resulted in an array of strategies for minimising selection for resistance and for dealing with it once it has developed. Importantly, many of these strategies are now supported by empirical science and some have been assessed and evaluated on commercial farms.

In sheep the cost of resistance has been measured at about 10% of the value of the lamb at sale which means that losses due to undetected resistance far outweigh the cost of testing anthelmintic efficacy. Despite this many farmers still do not test for anthelmintic resistance on their farm.

Many resistance management strategies have been developed and some of these have been tailored for specific environments and/or nematode species. However, in general, most strategies can be categorised as either; identify and mitigate high risk management practices, maintain an anthelmintic-susceptible population in refugia, choose the optimal anthelmintic (combinations and formulations), or prevent the introduction of resistant nematodes.

Experiences with sheep farmers in both New Zealand and Australia indicate that acceptance and implementation of resistance management practices is relatively easy as long as the need to do so is clear and the recommended practices meet the farmer's criteria for practicality. A major difference between Australasia and many other countries is the availability and widespread acceptance of combination anthelmintics as a resistance management tool.

The current situation in cattle and horses in many countries indicates a failure to learn the lessons from resistance development in small ruminants. The cattle and equine industries have, until quite recently, remained generally oblivious to the issue of anthelmintic resistance and the need to take pre-emptive action. In Australasia, as in other countries, a perception was held that resistance in cattle parasites would develop very slowly, if it developed at all. Such preconceptions are clearly incorrect and the challenge ahead for the cattle and equine industries will be to maximise the advantages for resistance management from the extensive body of research and experience gained in small ruminants.

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1. Introduction

Nematode parasites are a significant threat to the productivity of grazing livestock throughout much of the world, and many livestock owners depend on anthelmintics to minimise worm populations and maintain animal performance (Waller, 2006). However, the effectiveness of anthelmintics, and the welfare and production benefits they bring, is threatened by the increasing prevalence and severity of anthelmintic resistance (Besier, 2007; Kaplan and Vidyashankar, 2012). In sheep and goats, and in some countries also in cattle and horses, the presence of resistant worm populations is the status quo rather than the exception (Kaplan, 2004; Waghorn et al., 2006a; Kaplan and Vidyashankar, 2012). In many cases, the presence of resistance does not jeopardise effective worm control, which can be maintained simply by switching to use of an alternative class of anthelmintic to which resistance has not yet developed. However, as has been clearly demonstrated by experiences in goats and sheep, this is not a long-term solution, as resistance eventually develops to other classes as well. Hence, anthelmintic resistance in small ruminants in some countries involves all anthelmintic groups and combinations, except for the new actives monepantel and derquantel, and all major nematode genera (Besier and Love, 2003; Kaplan, 2004; Waghorn et al., 2006b; Kaplan and Vidyashankar, 2012). It is an inevitable conclusion that consideration of anthelmintic resistance and its management should be an integral component of anthelmintic use regardless of country or host species (Besier, 2007; Kaplan and Vidyashankar, 2012; Leathwick, 2013).

The need to combat anthelmintic resistance in small ruminants has resulted in considerable research effort to understand the dynamics of selection for resistance, and to develop strategies to minimise either initial or ongoing selection (Barnes et al., 1995; Leathwick et al., 2001, 2009; Woodgate and Besier, 2010; Kenyon and Jackson, 2012). As a result, in Australasia and some other countries such as the United Kingdom and South Africa, there exists today an array of resistance management strategies; many based on sound scientific evidence and some of which have been evaluated on commercial farms (van Wyk and Bath, 2002; Besier, 2012; McMahon et al., 2013; Leathwick, 2013). Unfortunately, there is little equivalent information regarding the management of anthelmintic resistance in cattle (Sutherland and Leathwick, 2011) or horses (Nielsen, 2012). While some aspects of the selection process, and therefore resistance management, are likely to be universal across host species, there will also be aspects which are different (Sutherland and Leathwick, 2011). For example, the dynamics of development and survival within the faecal pat (Young, 1983), and the pharmacokinetics and routes of administration of anthelmintics are likely to differ between sheep and cattle (González et al., 2009; Sutherland and Leathwick, 2011). The opportunity presented by the previous work in small ruminants is to capitalise on the knowledge and principals which have universal application, and to allow the focussing of resources onto those aspects which are specific to a given host or environment.

Here, we review strategies for the management of anthelmintic resistance in Australasia, the evidence supporting their development, and, where appropriate, experiences regarding their adoption on-farm. While most of the literature reports on studies involving parasites of sheep, we attempt to take a more general view encompassing general principles and aspects applicable to a wider range of host species.

2. Economic costs of anthelmintic resistance

Although sub-clinical worm burdens are well-recognised as a major cause of reduced animal production (Barger, 1982), few investigations have quantified the potential effects of impaired worm control resulting from anthelmintic resistance. Two recent New Zealand studies have quantified the cost in lamb production of using an anthelmintic for which efficacy is compromised by resistance at approximately 10–15% of carcass value (Sutherland et al., 2010; Miller et al., 2012). These trials measured only the immediate cost in lamb value and did not attempt to measure less tangible effects of sub-clinical parasitism such as ewe fecundity. However, the second trial (Miller et al., 2012) did demonstrate additional costs in that resistance necessitated holding lambs on the farm for longer (an average of 17 days), which would have required consumption of more pasture and reduced other financial opportunities. Further, the resistant parasites involved in these studies were *Teladorasgia* (*Ostertagia*) *circumcincta* and *Trichostrongylus colubriformis*. Had the resistance involved more pathogenic species, such as *Haemonchus contortus*, then production losses would undoubtedly have been greater.

A study in Western Australia indicated a similar scale of loss attributable to anthelmintic resistance in *T. circumcincta* and *Trichostrongylus* spp. Lambs treated with an anthelmintic that had reduced efficacy due to resistance suffered a 10% loss of wool production and growth rate compared to lambs given a fully effective anthelmintic. This study also highlighted the often insidious nature of anthelmintic resistance, in that clinical differences between the groups were minimal for most of the year-long study, only becoming obvious towards the end as efficacy declined and worm burdens accumulated (Besier et al., 1995). By the time overt anthelmintic failure is noted in such situations, the anthelmintic involved is likely to be ineffective for further use, except perhaps in a combination formulation.

There are few reports of the effects of anthelmintic resistance in nematodes of cattle. A recent study in Brazil (Borges et al., 2013) found that anthelmintic treatments which failed to adequately control resistant *Haemonchus placei* and *Cooperia* spp. resulted in a reduction in average daily weight gain of 60–90 g/day, which at 112 days post-treatment equated to a difference in liveweight of >9 kg. A small scale New Zealand study (i.e. 4 groups of 15 animals) found that use of an anthelmintic which did not adequately control *Cooperia* spp. reduced daily weight gain by an average of 100 g, resulting in a 6 kg difference in liveweight after 60 days (Leigh and Hunnam, 2013). A larger New Zealand study compared the growth rates of beef steers up to 18 months of age under routine treatment with anthelmintics that were either effective or ineffective against resistant