Roundworms and anthelmintic resistance

Roundworms, or nematodes (especially gastro-intestinal nematodes - GIN), are some of the most common parasites of sheep. Symptoms for GIN in sheep vary dependent on the parasite present, but generally include scours, severe weight loss and anaemia. Sub-clinical cases present a detrimental effect on production generally through a reduction in daily liveweight gain and ultimately longer days to finish. To control parasitic infections in livestock, anthelmintics have been in use since the 1960s. However, extensive use of these drugs has led to the development of widespread global resistance and in some areas, parasites are known to be multidrug resistant. A 2015 report by HCC shows that resistance in Wales has increased compared to studies completed in 2005. Furthermore, scientific modelling taking into account both climate change and worm behaviour, highlighted that in temperate climates, such as Wales, seasonal infection dynamics will change and annual infections of certain worms will increase. This calls for regular monitoring of GIN on farms, as well as anthelmintic effectiveness, to develop farm specific control programmes. Furthermore, on-farm management strategies need to change to lengthen the life of the two new classes of anthelmintics. These improvements will move towards a more sustainable approach to roundworm control.

What is resistance, how does it develop and how do we detect it?

When parasites are able to survive an effective anthelmintic treatment they are classed as resistant. Unfortunately, the trait is heritable and therefore passes to the next generation of worms. Many modern livestock practices favour selection pressures for resistance, which has increased the rate of development. Such practices include repeatedly treating whole flocks, especially when there is no knowledge of the efficacy of the drug and treatment of ewes around lambing with a long acting anthelmintic. Recent studies have identified a new risk factor through the use of a long lasting anthelmintic given to ewes 10 days before lambing, which passes at sub therapeutic levels to lambs through milk. Levels of the drug are detectable in lamb serum at a higher concentration than the mother's up to two months after the treatment. This is a prime example of resistance selection, as the drug follow through is able to reduce the worm burden of parasites susceptible to drugs, but not those resistant, thus leaving the lambs with a resistant worm population.

Testing for resistance on farms is essential so that control practices and treatments can be based on informed decisions. The most common method is the faecal egg count reduction test (FECRT) using the McMaster method. If egg counts are not reduced by over 95% post treatment, resistance is normally presumed. However, the test has limitations, including decreased sensitivity if worm burdens are low. Newer methods such as larval development and migration assays are less laborious than FECRT and allow the analysis of more than one drug at a time, but are not available for all the anthelmintic classes. Molecular diagnostics are perhaps the most accurate to test for resistance through analysis of specific genes or mutations indicative of resistance. However, further work is needed to develop these new techniques for their use in sustainable control monitoring programmes on farm.

Management changes

Although it is unlikely that nematode control will be managed without anthelmintic use, there are several on-farm management practices that can minimise their use, without any detriments to

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development: Europe Investing in Rural Areas
Llywodraeth Cymru Welsh Government

production. Several nutritional aspects are included within these practices; these will be covered in a future Farming Connect technical article.

Common practice is to treat the whole flock with anthelmintics, however, it is beneficial to leave a proportion untreated to create a small population of parasites that are able to survive, or a refugia of susceptible parasites and not select for resistance alone. Although this does not prevent resistance development, it does slow it by making sure the resistant roundworms don't become dominant in the population. Two methods to create a refugia are used: targeted treatment (TT), treats the whole flock at specific times, such as weaning or when FEC rise above baseline levels. However, development of this system requires a detailed knowledge of the farm itself and appropriate baseline levels of parameters such as flock FEC. Targeted selective treatment (TST), treats individual animals based on a set parameter, which will result in some animals not being treated. Parameters are normally linked to production, e.g. weight gain; or functional changes associated with the infection, e.g. FEC. Both methods reduce the use of anthelmintics, without detriment to daily weight gain and days to finish. Through a TT system, the savings attributed to a reduction in anthelmintics were approximately £660 per year. TST systems will incur more costs through increased labour by weighing lambs regularly. However, through this process, lambs are identified earlier as having reached target weights and are removed from production. These systems will benefit from automatic weighing systems or development of economic pen side diagnostic tests.

Grazing management can be improved for parasite control through the practices such as reduction in stocking densities, or co-grazing with cattle and sheep. As nematode parasites are often host specific, cattle can be grazed on pasture with low contamination to reduce the parasite load before susceptible sheep are introduced.

Finally, genetic selection of lambs for tolerance to nematode infections or resistance is crucial for sustainability in nematode control. However, despite successful results, on-farm uptake has been slow. There has been considerable debate between scientists as to whether resistance or tolerance should be bred for. Ultimately, tolerance is more sustainable, as parasites are less likely to develop resistance themselves. However, in practice it is much easier to select for resistance through phenotypic methods such as reduced FEC. Over several generations, genetic selection programmes reduce FEC which subsequently reduces pasture contamination. Genetically resistant sheep have a better immune response to the parasites and graze further away from dung, the source of the parasites. To further develop this system, the discovery of highly heritable immune biomarkers will be useful in future selection programmes.

SCOPS (http://www.scops.org.uk/) is an essential resource for all sheep farmers to improve both understanding and management practices relating to anthelmintic resistance. Farmers adhering to SCOPS guidelines are able to reduce their anthelmintic usage whilst maintaining production outputs.

Future scientific developments

Knowledge of all the pharmacological actions of anthelmintics is lacking, therefore, scientists are developing a better understanding of the current drugs that are available. Thus, activity of the drugs

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development: Europe Investing in Rural Areas
Llywodraeth Cymru Welsh Government

may be improved and management developed sustainably, which will be imperative for the newer classes of anthelmintics.

Development of new classes of anthelmintics is both expensive and lengthy, therefore the commercial availability of a new class should not be relied on for the near future. However, laboratory studies have looked at essential oils, such as tea tree oil, where anti-parasitic properties have been identified against nematodes. These are just one aspect of alternative therapies research in parasitology. However, although promising, these investigations are still very much at the developmental stage, and further work is required to investigate their efficacy in the live animal.

Parasite vaccine development is something that many farmers are interested in. Barbervax, was the first vaccine developed for a worm parasite of sheep (Barber's pole worm) but is only available in Australia, where the worm is a serious problem. However, this shows that vaccine development is possible and can be successful. Future developments are likely to investigate natural or hidden antigens that are specific to nematodes, to produce recombinant vaccines.

To encourage adoption of the principles overviewed in this article, better education surrounding anthelmintic resistance and how to combat it is required. This should include the benefits of changing management, effects on production and financial returns. It is imperative that farmers, vets, advisors and parasitologists work together to drive development on this subject.