Small Ruminant Research 118 (2014) 35–40

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Sustainable helminth control practices in the United Kingdom☆

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ARTICLE INFO

Article history:
Available online 16 December 2013

Keywords:
Sheep
Helminth
Nematode
Parasite management
Sustainability

ABSTRACT

Parasitic helminths are highly complex organisms with large, polymorphic genomes and enormous biotic potentials. They have evolved over millions of years to exploit whatever conditions arise, and will continue to do so in response to adverse stimuli such as practices aimed at their control, or advantageous stimuli, for example afforded by climatic variation and economics-driven changes in farm management. Helminth control is therefore definitely unsustainable and the challenge facing UK sheep farmers is to ensure that current measures enable economically viable sheep production for long enough to allow for the development of new strategies, before the existing methods eventually fail. This paper was presented at the 2013 Eighth International Sheep Veterinary Congress, illustrating certain areas in which the unsustainability of helminth control in UK sheep has already been identified, and summarising approaches that are being taken to enable adequate productivity in the face of such challenges.

1. Introduction

The principal reason for farming sheep is to convert primary forage, herbage or cereal crops into a marketable product, hence the profitability of global sheep production is heavily influenced by the efficiency of conversion of these primary crops into meat, wool, milk, or skins; the UK sheep industry being primarily focussed on meat production. The feed to meat conversion efficiency is greater in sheep that achieve maximal growth rates than in ill-thrifty animals, because there is a daily nutritional requirement for maintenance which must be met before growth can occur, irrespective of the time taken to reach slaughter weight. Furthermore, sheep and cattle which are slow to finish are more susceptible to compounding effects of production limiting diseases such as helminth parasitism, trace element deficiencies and respiratory disease than rapidly growing animals which may leave the farm before the main risk period for these problems. It is also intuitive that net greenhouse gas emissions from efficiently produced ruminant livestock are less than those from ill thrifty animals, reflecting differences in the amounts of feed that must be metabolised per kg of meat produced. Worldwide, helminth parasites are arguably the most important causes of suboptimal productivity in sheep, hence their sustainable control is a prerequisite for economically efficient farming.

Parasitic helminths are thought to have evolved from free living organisms that were present in oxygen-starved, benthic deposits as long as 1000 million years ago and have become highly complex and parasitic as their hosts emerged and co-evolved during the past 350 million years (Sutherland and Scott, 2010). The long-term biological success of parasites depends in part on their ability to coexist with their hosts in a sustainable manner whereby the host provides the conditions required by the parasitic population, while the parasite does not compromise

☆ This paper is part of the special issue entitled: Keynote lectures of the 8th International Sheep Veterinary Congress, Guest Edited by D.M. West and A. Ridler.

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http://dx.doi.org/10.1016/j.smallrumres.2013.12.019

the host to an extent that would threaten the survival of its future generations. In relatively recent times, the sustainable evolutionary balance between parasites and their sheep hosts has been upset by domestication and the subsequent development of intensive livestock management practices, which have created environments that: are suited to the development and survival of free living stages of the parasites; enhance sheep exposure to infective larvae; inadvertently alter the host innate or adaptive immune responses to infection; and enable exposure to previously unrecognised parasitic helminth species or strains. Furthermore, these conditions may have affected different parasite species to differing extents, upsetting the sustainable equilibrium that may exist in the environment and within the sheep host between different parasites, affording a competitive advantage to some and allowing these and other species to predominate and potentially become pathogenic.

2. Helminth control

Understanding the principles and constraints to the control of helminth parasites is of global relevance. Helminth parasites can be controlled conventionally either by evasion, or by suppression primarily involving pharmaceutical treatments of their hosts.

2.1. Nematodes

The simplest way in which to avoid potentially production-limiting infective nematode larval challenge is to manage sheep extensively, by adopting low stocking densities and co-grazing or browsing with other ruminant species on a variety of mature herbage plants. However, such management is not conducive towards economic sheep meat, wool or milk production. Alternative planned evasive strategies are based on the principles that survival of infective larvae is limited, being negatively influenced by effects of increasing temperature and decreasing moisture on their microhabitat, and that while sheep and goats are hosts to several of the same parasitic nematode species, cattle and deer are not. Thus, in regions such as northern UK which have temperate climates, pastures harbouring relatively low levels of infective larvae can be generated in principle by the removal of susceptible sheep for a period of about 6 months. This strategy can be conducive to economic productivity whenever it is practical to: finish naïve meat producing lambs quickly, thereby removing them early in the grazing season; or to utilise the fields for cattle grazing, forage conservation, or cereal production during the period while the sheep are excluded. However, in practice, conditions influencing the biotopes of different parasite populations are poorly understood and cannot be measured, while host–parasite relationships of different host and parasite species are complex. Furthermore, on most UK farms, the reasons for keeping sheep are to produce a marketable product from areas that are not suited to other efficient means of agricultural production, or to manage areas for other environmental or non-agricultural purposes. As a consequence, the grazing requirements of the sheep are high relative to those of cattle, or the equivalent area taken up by cereal production, precluding the economic application of evasive management strategies as the sole method of parasitic nematode control, and necessitating the strategic use of pharmaceutical treatments of their sheep hosts with the aim of suppressing the size of the infective larval population.

In fact, in the relatively short term, the development of modern anthelmintic drugs has enabled economic productivity in many situations where economic, intensive sheep production would otherwise have been untenable due to the effects of nematode parasites. Most UK farmers have become dependent on pharmaceutical nematode parasite control strategies with the aim of striking a balance between the levels of larval challenge that might impair animal performance and those required to enable the development of protective immunity (Coop et al., 1982). Regular pharmaceutical treatments are given with the aim of reducing the level of nematode egg shedding onto pasture, thereby suppressing the infective larval challenge to naïve animals, albeit that dependence on pharmaceutical treatments for disease control in this manner inevitably selects for anthelmintic resistance.

2.2. Trematodes

Following a series of particularly wet years, both the prevalence and the severity of fasciolosis in the UK have increased greatly, causing poor reproductive performance, ill thrift in adult animals, poor lamb growth rates and deaths in sheep flocks throughout the country, and not just in historic high-risk regions. The periods of high metacercarial challenge have become longer and less predictable, driven by: changing patterns of seasonal temperature and rainfall; economics and regulation-driven changes in grazing management; and also putatively due to changing parasite biology, for example influencing the fluke's ability to overwinter in its intermediate snail host, or as metacercariae. The principles of control of fasciolosis include integration of host evasion of high levels of metacercarial challenge, pasture management to control snail and free-living fluke stage habitats, and the strategic use of flukicidal drugs with the aim of interrupting the parasite lifecycle through reduced host egg shedding.

During recent years the paramphistome rumen fluke, *Calicophoron daubneyi* has emerged on many UK sheep and cattle farms (Gordon et al., 2013), presumably having been introduced with cattle imported from northern Europe and being afforded opportunities to complete its lifecycle, involving development in intermediate snail hosts by climate and environment. The pathogenicity of *C. daubneyi* in sheep is unknown and probably low, although immature stages in the duodenum and migrating through the abomasum have been associated with diarrhoea and deaths in both sheep (Mason et al., 2012) and cattle (Millar et al., 2012). The species identity of the intermediate snail hosts in the UK has not been conclusively demonstrated, hence planned evasive management is unproven. Anthelmintic drug treatment depends on use of oxyclozanide, only available in the UK in combination with levamisole.