Preventive Veterinary Medicine 109 (2013) 228–235

Contents lists available at SciVerse ScienceDirect

Preventive Veterinary Medicine

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

Conceptual framework for analysing farm-specific economic effects of helminth infections in ruminants and control strategies

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ARTICLE INFO

Article history:
Received 18 June 2012
Received in revised form 25 October 2012
Accepted 26 October 2012

Keywords:
Animal diseases
Helminth
Farm economics
Interdisciplinary framework
Production theory
Farm-specific

ABSTRACT

Helminth infections are considered to be an important constraint on livestock productivity worldwide. The economic impact of these infections or their control strategies has traditionally been assessed by their effect on animal performance indicators or traditional economic calculation methods (e.g. budgeting and cost-benefit analysis). Because the impact of helminth infections has become more subtle and is farm-specific, one needs more refined economic evaluations of actions meant to increase or maintain the health of livestock on individual farms. This paper proposes an interdisciplinary framework that combines the developments in the veterinary control of helminth infections with economic performance measurements to identify farm-specific and profitable anthelmintic management decisions. Our framework positions individual farms' performance against performance benchmarks and is based on the farms' efficiency in transforming input(s) into output(s). We show how this positioning makes it possible to establish a linkage between input and output transformation, helminth infection levels and effects of control strategies. Furthermore, the framework allows for the identification of improvement paths that are not necessarily related to the helminth infection, but which may lead to other management improvements. We discuss the epidemiological information required and which complementary methods (e.g. efficiency analysis and budgeting techniques) can be used to make the framework operational.

1. Introduction

The competitiveness of European livestock farms is being challenged by more critical social expectations (e.g. animal welfare and environmental sustainability) and increasing competition for raw materials and livestock products (Thornton, 2010). To remain competitive, individual farmers need to make the right decisions and address multiple issues. In this paper, we consider decisions related to animal health management.

In the past 25 years, changes in animal health management have led to a shift in focus from disease treatment to prevention and from the individual animal to herds (LeBlanc et al., 2006). Prevention and vaccination programmes have resulted in successful elimination of several infectious diseases, such as rinderpest and foot and mouth disease (Sutmoller et al., 2003; Roeder, 2011). In contrast, helminth infections are more persistent and are rarely eliminated (Le Jambre, 2006). Nevertheless, the level of helminth infections has decreased in many production systems and their appearance has shifted from clinical

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http://dx.doi.org/10.1016/j.prevetmed.2012.10.017

to mostly subclinical (Vercruysse and Claerebout, 2001; Fairweather, 2011).

The economic situation of livestock farms has also changed over the years. The pressure on farm income has increased due to higher production costs and fluctuating output prices (Thornton, 2010). This results in small profit margins for farmers, which implies that even minor production losses may have a disproportionate effect on these margins (Van Meensel et al., 2010a). Despite the relatively subtle production impact of helminth infections, their economic impact may still be important. In addition, each farm's economic situation differs due to differences in productivity. Farm productivity depends on multiple factors: scale (number of production animals) of the farm, the amount of output produced, the amount of inputs used, the level of disease prevalence, and management and regional restrictions (Bennema et al., 2010; Wilson, 2011). These differences in farm productivity lead to differences in the farm-level economic effects of helminth infections and/or control strategies.

In this changing socio-economic environment, the need is growing for more advanced economic measurements of the efforts applied to increase or preserve the health of livestock. In literature, traditional approaches (e.g. budgeting and cost–benefit analysis) are mostly used to account for the economic effect of helminth infections or control strategies on livestock farms (Holzhauer et al., 2011; Charlier et al., 2012b). The question arises whether these traditional approaches are sufficiently refined and farm-specific to evaluate the economic impact of subtle helminth infections. The evolutions in the epidemiology of helminth infections and economic performance measurement have created an opening for the development of farm-specific economic evaluations. The aims of this paper are (1) to explore the recent advances in helminth control and the methodologies for economic performance measurement and (2) to construct an interdisciplinary framework that integrates both disciplines to perform refined and farm-specific evaluations of the economic impact of helminths and their control strategies.

First, the advances in helminth control and the current epidemiological situation of the most important helminth infections in livestock are briefly described. Then an overview of traditional approaches used to assess the economic impact of helminth infections and their control strategies is given, followed by recent developments in the economic evaluations of animal diseases and control strategies. Next, we present an interdisciplinary framework that combines the advances of helminth research and economic performance measurement. Finally, we discuss the prerequisites to make such a framework operational.

2. Economic important helminth infections and their current epidemiological situation in temperate climate regions

Table 1 presents a summary of the most important helminth infections of livestock in temperate climate zones and their current epidemiological situation. Scientific advances in helminth research have significantly contributed to reduce the economic burden of helminths by the development of highly efficacious anthelmintic drugs (Woods et al., 2011), new diagnostics (Höglund, 2011; Knox et al., 2012), the quantification of risk factors for disease

Table 1
Epidemiology and economic impact of important helminth infections of livestock in temperate climate zones.

Parasitic species	Epidemiological development	Economic importance	References
Gastrointestinal nematodes	All grazing cattle are exposed. Anthelmintic treatment strategies are widely applied and clinical disease incidence has decreased substantially. But the incidence of nematodes resistant against anthelmintic drugs is increasing, which create a pressure for alternative control approaches.	Reductions in weight gain and milk production.	(Charlier et al., 2009a; Sutherland and Leathwick, 2011)
Fasciola hepatica	Prevalence shows regional variation depending on suitable conditions of the intermediate host snail. Infections are mostly subclinical, but clinical presentation can occur in heavily infected animals (mostly sheep). Climate change is considered as a threat due to the risk of increasing incidence of fasciolosis.	Reductions in weight gain, fertility and milk production.	(van Dijk et al., 2010; Dutra et al., 2010; Fairweather, 2011)
Dictyocaulus viviparus	Responsible for sporadic outbreaks of severe respiratory symptoms in pasture-based cattle farms. Intensive application of anthelmintic drugs in young stock has led to increased incidence of clinical outbreaks in adult cattle.	Mortality, reductions in weight gain and milk production.	(Ploeger, 2002; Holzhauer et al., 2011)
Ascarissuum	Infections thrive in both in- and outdoor kept pig populations, and are gererally subclinical. Anthelmintics are commonly used to control ascariosis.	Reductions in weight gain and feed conversion rates.	(Dold and Holland, 2011; Sanchez-Vazguez et al., 2012)