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A longitudinal study of gastrointestinal parasites in English dairy farms. Practices and factors associated with first lactation heifer exposure to *Ostertagia ostertagi* on pasture

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ABSTRACT

The gastrointestinal nematode *Ostertagia ostertagi* is an important cause of lost production, health, and welfare in cattle. Detailed records were obtained over a 5-yr period (2010–2015) by questionnaires and qualitative interviews to investigate the practices adopted by dairy farmers to control cattle helminth infections and the factors associated with heifer exposure to *O. ostertagi* on pasture. In total, 1,454 heifers' individual milk samples were collected over a 1-yr period (2014–2015) in 43 dairy farms in England and tested for *O. ostertagi* antibody by ELISA. Multilevel linear regression models were used to investigate the association between individual milk optical density ratio (ODR) against *O. ostertagi* and heifer management from birth to time of sampling. Farm and heifer median ODR against *O. ostertagi* were 0.98 (interquartile range = 0.76–1.02) and 0.64 (interquartile range = 0.42–0.84), respectively. The majority of heifers (88%) received an anthelmintic treatment before sampling in this study. After controlling for the effect of anthelmintic treatments, heifer individual milk ODR against *O. ostertagi* significantly increased with high stocking rate at first grazing and co-grazing with adult cows before calving. Conversely, heifer individual milk ODR against *O. ostertagi* significantly decreased when heifers had co-grazed with sheep and pasture grass had frequently been mowed. Overall, these results provide evidence to support targeting grazing management toward limiting the use of anthelmintics in dairy young stock to enable sustainable control of cattle helminth infections in England. However, to be accepted and adopted by farmers, these best practices would need to take into account farmers' perspectives and contextual challenges.

Key words: dairy heifer, *Ostertagia ostertagi*, individual milk ELISA, sustainable control

INTRODUCTION

Ostertagia ostertagi infections are one of the main concerns in the cattle industry in England (Bellet et al., 2016; Berk et al., 2016). Extensive negative effects of cattle helminths have been reported, including loss in milk production, decreased growth performances, impaired reproduction, and poor welfare (Sanchez et al., 2002a; Charlier et al., 2014; Bellet et al., 2016); moreover, cattle infected with helminths produce more greenhouse gases (Rushton and Bruce, 2017). As cattle helminth infections are mainly subclinical, their control is often difficult (Charlier et al., 2014) and mostly relies on the indiscriminate use of anthelmintic drugs (Vercruysse and Claerebout, 2001). In the United Kingdom (**UK**), concerns over cattle anthelmintic resistance have led to the development of the Control Of Worms Sustainably guidelines (COWS, 2010), but their adoption by cattle farmers in England is still unsatisfactory (Heasman et al., 2012). Whereas some information is available on the use of management practices by sheep farmers for helminth control in England (Morgan et al., 2012), scant data exists on the same for the dairy farmers.

To implement helminth control, farmers need to use basic epidemiological information (Vercruysse and Claerebout, 2001). This includes information on a wide range of factors on which exposure of cattle to helminths depends; for example, climate, farm management (e.g., stocking rate and mowing), and availability of resources (Charlier et al., 2015; Wilson et al., 2015). In dairy farms, this is particularly relevant to heifers, as these are the future of the milking herd and usually the focus of anthelmintic treatments (COWS, 2010; AHDB, 2015). However, estimations of dairy heifer

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exposure to helminths on pasture are currently unavailable in England. In fact, no survey on the prevalence of helminths in dairy heifers have been conducted in England since the 1980s (Hong et al., 1981). Moreover, although the identification of risk factors associated with cattle exposure to *O. ostertagi* has been the focus of much research, there is a lack of similar research focused on heifers. In addition, it remains unknown if and how these risk factors can interplay and vary over the lifetime of the cattle (Charlier et al., 2005a; Bennema et al., 2009; Vanderstichel et al., 2012). One possible reason for this is the use in previous research of close-ended questionnaires, which restricts the representation of complex systems of management and grazing (Bennema et al., 2010; Merlin et al., 2016). This is especially the case when these approaches are applied to systems such as the ones adopted in England, where cattle graze in rotation (AHDB, 2013). Second, previous studies mainly relied on bulk tank milk (**BTM**) indicators of cattle exposure to helminths whose antibody levels are difficult to interpret because of the pooled nature of the samples (Sekiya et al., 2013). Evidence suggests that because levels of *O. ostertagi* antibody in cows are highly varied within a farm, the use of individual milk (**IM**) samples for this type of research is a better approach (Charlier et al., 2007; Blanco-Penedo et al., 2012).

The goal of our research was to provide a better understanding of strategies to improve the control of helminth infections in heifers in England. To achieve this, we used a longitudinal study (integrating both retrospective and prospective data on individual heifer management, from birth to first lactation) to explore (1) levels of herd and heifer exposure to helminths, (2) farmers' practices for cattle helminth control, and (3) factors associated with heifer exposure to *O. ostertagi* on pasture.

MATERIALS AND METHODS

Study Herds

Heifers came from a convenience and purposive sample of 43 dairy farms, all members of the Quality Milk Management Services (**QMMS**) recording scheme in Somerset, England. The average size of herds sampled was 150 cows, of which 46 were first-lactation heifers. Farms were selected to allow the representation of different levels of heifer exposure to helminths and heifer management. Farm selection criteria included heifers calving all-year-round or at least during 2 different seasons in a year, home rearing of heifers (i.e., not contract reared), compliance on data recording, agreeing with the study protocol, and sharing farm records.

Heifer IM samples were obtained from samples routinely collected and stored by QMMS. All heifers entering in first lactation from the beginning of March 2014 to the end of March 2015 were eligible for the study. A total of 1,500 heifer samples were selected by stratified random sampling, with the season and the farm as the strata (Dohoo et al., 2009). The selection of the samples was conducted in 2 steps (October 2014 and June 2015). We aimed to obtain 375 heifer samples per season and 35 per farm. A flowchart of the selection process of the samples is presented Figure 1. Inclusion criteria were DIM (i.e., between 30–90 DIM to limit the confounding effect of milk production factors on antibody levels; Sanchez et al., 2004), presence of QMMS sample records on milk yield, fat, protein, and SCC, and absence of heifer grazing in 2015. In the case where multiple samples had been collected from a heifer, only the sample with the lowest DIM was kept to be tested.

Data Collection

The study was approved by the ethics committee of the School of Veterinary Medicine and Science, University of Nottingham, and participating farmers were asked to sign an informed consent form. Detailed retrospective and prospective information on heifer's demographic and management was obtained for a 5-yr period from 2010 to 2015. This way, each sampled heifer presented a complete management history from birth to sampling.

Postal Questionnaires (Retrospective Information on Heifer General Management). Retrospective information on demographic (i.e., farm and heifer) and general young stock management (i.e., housing, feeding, and vaccination) was gathered for each heifer and farm using close-ended questionnaires. Information was collected for the years 2010 to 2013, assuming that first-lactation heifers could calve from 30 mo onwards in Great Britain (AHDB, 2014). Questions were grouped into sections according to topics (e.g., demographic, housing, and vaccination) and animal category (e.g., preweaned calves, weaned calves, and bulling heifers). Questions were asked for the year 2013 and, in the case of any change from the previous years (i.e., 2010–2012), farmers were asked to specify this change. Before its distribution, the questionnaire was pilot-tested on 3 colleagues of the dairy herd health research group at the School of Veterinary Medicine and Science, University of Nottingham. Collected data were validated with farmers during a subsequent farm visit.

Farm Visit (Retrospective Information on Heifer Grazing Management). Forty-three face-to-face semistructured interviews were conducted by the lead author (CB) during a farm visit between April and