Preventive Veterinary Medicine 120 (2015) 162–168

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

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

Dairy cattle management factors that influence on-farm density of European starlings in Ohio, 2007–2009

Genet A. Medhanie[a,*], David L. Pearl[a], Scott A. McEwen[a], Michele T. Guerin[a], Claire M. Jardine[b], Jeffrey T. LeJeune[c]

[a] Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON N1G 2W1, Canada
[b] Department of Pathobiology, Ontario Veterinary College, University of Guelph, Guelph, ON N1G 2W1, Canada
[c] Food Animal and Health Research Program, Ohio Agricultural Research and Development Center, The Ohio State University, Wooster, OH 44691, USA

ARTICLE INFO

Article history:
Received 3 October 2014
Received in revised form 2 April 2015
Accepted 27 April 2015

Keywords:
Dairy farm
Feed
Negative binomial
Roost
Starlings
Zero-inflated

ABSTRACT

Potential dairy farm management and environmental factors that attract European starlings (*Sturnus vulgaris*) to dairy farms were explored. During the period from 2007 to 2009, 150 dairy farms were each visited twice (once during the summer and again in the fall) and the number of starlings was recorded. Risk factors were assessed for possible association with the number of starlings per milking cow (starling density), using a zero-inflated negative binomial model. Starling density was higher on farms visited in 2007 compared to those visited in 2008 or 2009. The interaction term between feeding method and feeding site was significantly associated with starling density on farm; generally, feeding outdoors was associated with increased starling density. The odds of a zero starling count (compared to a count greater than zero) was higher on farms that removed manure from barns weekly or less frequently than weekly compared to those that removed manure daily or after every milking. The odds of a zero starling count decreased with increasing distance of a farm from the closest night roost. Identifying on farm risk factors that expose farms to starlings will help farmers develop strategies that minimize the number of birds on their farms and thereby reduce physical damage to the farms as well as the potential for pathogen transmission from birds to cattle and humans.

1. Introduction

European starlings are invasive and migratory birds that easily adapt to new environments (Feare et al., 1992). As a result, they have displaced several native bird species (Linz et al., 2007). They also destroy crops and consume livestock feed resulting in considerable economic losses to livestock industries. For instance, Feare and Wadsworth (1981) found that starlings consumed more than 10,000 kg of cattle feed from five farms during a study conducted in England over the winters of 1975 and 1976.

The perennial availability of food and water makes dairy farms attractive facilities to wild birds that frequent agricultural environments (Johnson and Glahn, 1994). European starlings (*Sturnus vulgaris*), English sparrows (*Passer domesticus*) and pigeons (*Columba livia*) are some of the wild birds that frequently visit dairy farms (Gough and Beyer, 1981; Cernicchiaro et al., 2012). Unlike English sparrows and pigeons, European starlings do not roost and forage at the same location (Gough and Beyer 1981), but travel away from their roosting sites searching for food (Johnson and Glahn, 1994; LeJeune et al., 2008). Although starlings are faithful to their major feeding sites (Bray et al., 1975; Homan et al., 2013) they can also have additional feeding sites (Glahn et al., 1987; Caccamise 1990).

These behaviors combined with their habit of moving among, as well as within, different areas of the same livestock farm, mean that starlings have the potential to disseminate pathogens to animals and humans (Gough and Beyer 1981). European starlings have been implicated in the transmission of pathogens such as *Escherichia coli* O157:H7 (Williams et al., 2011; Cernicchiaro et al., 2012; Swirski et al., 2014) *Salmonella* (Carlson et al., 2012), *Campylobacter* (Sanad et al., 2013), and *Mycobacterium avium* subspecies *paratuberculosis* (Corn et al., 2005) among cattle.

The association between the prevalence of *E. coli* O157:H7 and starling density in Ohio dairy farms has been investigated previously (Cernicchiaro et al., 2012). In that study, the prevalence of *E. coli* O157:H7 in cattle fecal pats was positively associated with starling density, supporting the hypothesis that these birds spread pathogens among dairy farms. This finding was further supported by the similarities in multiple-locus variable-nucleotide tandem repeat analysis (MLVA) subtypes of *E. coli* O157:H7 found in

* Corresponding author. Tel.: +1 519 841 5144; fax: +1 519 763 3117.
E-mail address: gasmelas@uoguelph.ca (G.A. Medhanie).

http://dx.doi.org/10.1016/j.prevetmed.2015.04.016
0167-5877/

Table 1
Farm management and farm structural variables examined for possible association with European starling density on Ohio dairy farms, 2007–2009.

• Temporal variables	• Type of barn	• Feed storage	• Manure removal
○ Year of visit (2007–2009)	○ Free stall	○ Silos	○ Every milking
○ Month (June–November)	○ Tie stall	○ Bagged	○ Daily
○ Season (summer/fall)	○ Both	○ Bunkers	○ Weekly or less frequently
		○ Other (bin, hay, open pit, uncovered pile, bales)	
• Distance of farm from roost sites (range in km)	• Stall bedding	• Feeding method	• Manure storage
○ Apple Creek roost (3.2–511.8)	○ Sand	○ Aisle	○ Lagoon
○ Morton (2.4–517.7)	○ Sawdust	○ Bunk	○ Pile
○ South Rittman (1.9–516.4)	○ Straw	○ Other (bale ring, pasture, hay ring, bunk on ground, in parlor)	○ Combination or other (slurry store, pit)
○ Lime Lakes (9.8–532.1)	○ Other (compost pack, mats, rubber mats, dirt)		
○ The closest roost (1.9–511.8)			
• Other farm management factors	• Type of roof	• Feed type	• Ventilation
○ Other animals on farm (Y/N)	○ Rafters	○ Total mixed ration	○ Doors
○ Domestic (Y/N)	○ Netting on rafters	○ Silage	○ Doors and curtains
○ Wild animals (Y/N)	○ Open roof	○ Grazing	○ Doors and open-sided
○ Heifers (Y/N)	○ Ceiling	○ Haylage	○ Other (fans, ridge vent, windows)
○ Calves (Y/N)	○ Other (rafter-less wood, aluminum sheet)	○ Combination	
○ Number of barns			
○ Number of milking barns			
• Water source	• Calf housing	• Feeding site	
○ Pond	○ Barn	○ Indoor	
○ Creek/stream	○ Hutches	○ Outdoor	
○ Pond and stream	○ Barn and hutches	○ Indoor and outdoor	
○ Other (ditch, fountain, lake)			

isolates from bovine and starling samples collected on different farms (Williams et al., 2011).

Understanding the factors that influence starling preference for particular farms could provide dairy producers and farm managers with the necessary information to reduce the population of starlings on their farms using non-lethal approaches. Consequently, the objective of our study was to identify farm management factors and farm structural features that influence the density of European starlings on dairy farms.

2. Material and methods

2.1. Data description

Data used in this study were collected for a previous study investigating associations between risk factors and the prevalence of *E. coli* O157:H7 carriage in cattle from Ohio dairy farms following the standard protocol recommended by research partners from the USDA National Wildlife Research Center (Great Plains Field Station, Bismark, ND, USA) (Cernicchiaro et al., 2012). One hundred and fifty dairy farms were each visited twice; once during the summer (June–August) and again in the fall (September–November); in 2007 ($n = 31$ farms), 2008 ($n = 54$), or 2009 ($n = 65$), except for one farm that was visited on three occasions in 1 year. On each visit, the number of starlings was counted on three areas of the farm (barns, feed storage, and manure storage) by one to three trained observers during the time of the day when starlings most frequently visit farms during these seasons (08:30–16:40 h) (Cernicchiaro et al., 2012). Birds were counted four times within an hour (every 10 min for 5 min). The highest of the counts among the counting periods was recorded as the number of starlings on the farm.

A questionnaire was administered to the farm owner or manager during the farm visits, and the following management and