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Stewarding dairy herd health and antibiotic use on U.S. Amish and Plain Mennonite farms

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ABSTRACT

This study uses a survey of dairy farmers in Michigan and Pennsylvania to examine self-reported antibiotic use and use of natural therapies to treat mastitis on dairy farms, comparing Amish and Mennonite (Plain) farmers to others. Plain farmers represent a large minority of U.S. farmers, and their proportion is projected to increase. Scholars suggest a unique environmental ethic amongst Plain farmers, and we extend this to examine antibiotic use. Antibiotic use is a key component of sustainability on dairy farms. Regarding environmental sustainability, imprudent antibiotic use is associated with the risk of antibiotic resistance and drug residues. Regarding economic sustainability, antibiotic use is associated with increased costs and lost production. Results suggest that Plain farmers use antibiotics less frequently than others and rely more frequently on natural therapies. However, Mennonite farmers more closely resemble non-Plain peers. This suggests the need to recognize the distinctiveness of Plain farmers and that Plain farmers may offer lessons on sustainable practices that could be extended to other farmers.

1. Introduction

In this study, we examine self-reported antibiotic use amongst U.S. dairy farmers, comparing Plain farmers (members of Amish or Mennonite religious communities) to other farmers. Antibiotic use in livestock production is important to several components of sustainability: environmental sustainability – human and non-human animal health – and financial sustainability. In the US, over 80% of annual antibiotic drug sales are for use in livestock (as opposed to human medicine) (Food and Drug Administration, 2014). Imprudent use of antibiotics in livestock production is associated with growing concerns about antibiotic-resistant strains of bacteria in both animal health (Makovec and Ruegg, 2003) and human health (Cuny et al., 2013; Nicholson et al., 2013; Rinsky et al., 2013). Antibiotic resistance is a threat to the environmental sustainability of dairy farming. Antibiotic use is also associated with lower milk production and quality (Losinger, 2005; Ma et al., 2000; Ott, 1999) and higher costs (Losinger, 2005), threatening the economic sustainability of dairy farming. An examination of antibiotic use is, therefore, both timely and central to several components of farm sustainability.

While the risk of emerging antibiotic resistance has been relatively low on dairy farms, particularly for drugs with high therapeutic value in human medicine (Erskine, 2011; Erskine et al., 2002b, 2004; Lindeman et al., 2013), prudent use of antibiotics similar to that advocated in human health is needed to ensure this remains the case (Weber, 2006). Also, while antibiotic resistance rates may be lower on dairy farms than other livestock sectors, culled (slaughtered) dairy cows accounted for 67% of illegal levels of drug residues by the USDA in 2010 (USDA, 2012) and 83% of the illegal drug residues in dairy cows resulted from antibiotics (USDA, 2012). Mastitis, the infection that accounts for the majority of antibiotic use on dairy farms, also hugely reduces milk production and milk quality, reducing farm profitability and income (Hogeveen, 2005; Losinger, 2005; Ma et al., 2000). Therefore, understanding antibiotic use on dairy farms and what factors could help reduce use contributes to expansion of environmental, social, and economic sustainability.

Several studies have demonstrated the importance of farmer behavior, attitudes, knowledge, and other sociological drivers of dairy animal health practices and antibiotic use. Scholars have highlighted the importance of labor management and dairy personnel to effective mastitis management and antibiotic use (Brasier et al., 2006; Fuhrmann, 2002; Stup et al., 2006). Additional research has demonstrated the importance of farmer attitudes and values in shaping mastitis rates and antibiotic use (Barkema et al., 1999; Jansen, 2010; Sato et al., 2008; Schewe et al., 2015; Vaarst et al., 2002). Together, this literature suggests that human and sociological variables may play an

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important role in antibiotic use and mastitis management, and we extend this literature through the examination of Plain farmers specifically.

We specifically compare Plain dairy producers to non-Plain or English[1] dairy farmers as they are an increasing fraction of the dairy farm population in key states like Pennsylvania (Winsten et al., 2000) and these trends are expected to continue (Cross, 2014; Donnermeyer et al., 2013). While the Amish are assumed to have a general creation care ethic that informs their farming pratices, how that may apply in specific contexts (Hockman-Wert, 1998) is not explored extensively in the literature, especially with examples relating to animal agriculture.

Given the increasing role of Plain farmers within the U.S. dairy industry, it is pertinent to examine potential differences in antibiotic use and farm goals between English and Plain farmers. To do so, we analyze a 2013 survey of dairy farms in Pennsylvania and Michigan. Comparing Amish, Mennonite, and all other respondents, we examine the frequency of use of both antibiotics and natural treatments for mastitis. Our sample of dairy farmers is 23% Amish, 25% Mennonite, and 51% all others. Our findings suggest several key divides between Plain and other farmers. Overall, we find that Plain farmers report using antibiotics significantly less often than non-Plain peers and using natural or organic therapies far more often, even when controlling for other key variables. However, we also find key differences between Amish and Mennonite farmers, suggesting Plain communities are highly diverse. Most scholarly research on the Anabaptists[2] focuses on the Amish rather than on groups like the Mennonites (Anderson and Donnermeyer, 2013) so this study is unique by focusing on members of both groups. Together, our findings highlight the role that Plain religious affiliation can play in shaping environmental behavior on farms, as well as the diversity within Plain communities.

Our findings suggest that scholars and practitioners must be sensitive to religious diversity within the U.S. dairy industry, particularly as they engage with questions of environmental behavior and specifically antibiotic use. Trends for less frequent antibiotic use and more frequent use of natural therapies amongst Plain farmers suggest that these communities may hold valuable lessons on sustainable farming that could be shared with the rest of industry as scholars and practitioners strive to reduce antibiotic use and improve milk quality in the U.S. dairy industry.

2. Literature review

2.1. Antibiotic use in the dairy industry

Antibiotic use in livestock production has recently gained both scholarly and popular attention. Increased resistance rates to common antibiotics amongst humans is a growing public health concern (Rossolini et al., 2014; Wyk, 2015), and public health scholars have attempted to identify key drivers of this increasing resistance (Gould, 1999). While scholarship has predominantly identified imprudent use of antibiotics in human healthcare as the primary driver of antibiotic resistance (Rossolini et al., 2014), the use of antibiotics in livestock has also been examined as a potential vector (Cuny et al., 2013; Pruden et al., 2012; Rinsky et al., 2013; Witte, 1998). Antibiotic use in livestock production has been framed as a key issue for social movement groups ranging from the Natural Resources Defense Council (NRDC) (The Natural Resources Defense Council, 2017) to the Consumers' Union (The Consumer Union, 2012). In September 2016, the NRDC and six other groups petitioned the Food and Drug Administration (FDA) to withdraw approval of antibiotics that are key to human healthcare for use in livestock production (Dall, 2016). Prior to this petition, in 2013 the FDA issued a voluntary request for drug companies to stop labeling medically important[3] antibiotics as appropriate for growth and production promotion in livestock (U.S. Food and Drug Administration, 2013).

While the majority of attention on antibiotic use within the livestock industry has focused on meat production (Witte, 1998), there is widespread use of antibiotics within the dairy industry, as well. In 2007, 16% of dairy cows were treated for mastitis with antibiotics (USDA, 2008) and 67% of drug residue violations were in culled dairy cows (USDA, 2012). Within the dairy industry, approximately 80% of antibiotic use is for mastitis (Pol and Ruegg, 2007). Mastitis can be treated with either intramammary antimicrobials that are infused into the teat-end or with systemic antimicrobials that are given either orally or subcutaneously (Saini et al., 2012). Veterinarians and dairy health experts widely regard intramammary antibiotics as more effective to treat mastitis with a targeted approach (Erskine et al., 2002a; Sérieys et al., 2005). The most commonly used antibiotics for mastitis treatment are cephalosporin (53.2% of treated cows) and lincosamide (19.4% of treated cows) (USDA, 2008). Both are considered "medically important" for use in human medical therapy (USDA, 2008).

Mastitis and subclinical infections can be caused by either contagious pathogens transmitted from cow to cow during milking or by environmental pathogens transmitted in housing and bedding (Agriculture and Horticulture Development Board, 2017). Coliform (E. coli and other bacteria) and Streptococcus uberis infections are typically associated with environmental transmission, while Staphylococcus aureus infections are typically associated with contagious infection from contaminated milking equipment or unsanitary milking procedures (Agriculture and Horticulture Development Board, 2017). Preventative practices for mastitis include maintaining clean and dry housing to prevent environmental infections, sanitary milking procedures, maintaining milking equipment to prevent cow-to-cow transmission, and culling cows with chronic infections (Hurley, 2010). Additionally, "dry treatment", or the preventative use of antimicrobials during the period in which a cow is not being milked, has been demonstrated to significantly reduce new mastitis infections (Spanu et al., 2011) as well as the use of vaccines (Pereira et al., 2011).

Within the U.S. dairy industry, there has been little evidence of antibiotic resistance (Erskine, 2011). There is, however, increasing attention from a variety of stakeholders - veterinarians, milk processors, consumers, and farmers - regarding the need for prudent antibiotic use (Landers et al., 2012; Oliver et al., 2010) and increasing overall milk quality. The European Union has lowered its somatic cell count (SCC)[4] standard to 400,000 cells per milliliter (anything above that threshold is deemed unfit for human consumption), while the U.S. SCC acceptable threshold remains 750,000 cells per milliliter (Petereson-Wolfe, 2011). Many industry leaders have suggested that the U.S. may soon lower federal SCC standards to approach those of the EU (Petereson-Wolfe, 2011). As described previously, mastitis and high SCC can also lead to substantial decreases in productivity, decreasing milk production by up to 11% per cow each year (Ott, 1999). Mastitis and high SCC are problematic for dairy processors due to decreased shelf life and limitations for some processed products (Ma et al., 2000). Most U.S. dairy processors pay farms an incentive or premium for milk that meets predefined SCC thresholds (Michigan Milk Producers Association, 2016), which can have a substantial impact on farm profitability when coupled

[1] It is common amongst Amish and conservative Mennonite groups to refer to non-Plain people as "English." The origins of this term are ambiguous, but we adopt this language throughout the paper in recognition of its importance to Amish scholars and peoples. Throughout the paper, the term "English" is used interchangeably with the term "non-Plain".

[2] Anabaptist is the broader religious tradition that includes both Mennonite and Amish communities (Redekop and Redekop, 2001).

[3] According to the FDA, "the term 'medically important' generally refers to antimicrobial drugs that are important for therapeutic use in humans" (Food and Drug Administration, 2012).

[4] Somatic cell count (SCC) is a measure of white blood cell concentration in the milk that is often used as a proxy for underlying mastitis problems or subclinical mastitis infection (Blowey and Edmondson, 2010).