J. Dairy Sci. 101:1–8
https://doi.org/10.3168/jds.2017-14297
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Factors associated with productivity on automatic milking system dairy farms in the Upper Midwest United States

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ABSTRACT

The objective of this study was to identify housing and management factors associated with productivity on automatic milking system (AMS) dairy farms measured as daily milk yield/AMS and daily milk yield/cow. Management, housing, and lameness prevalence data were collected from 33 AMS farms in Minnesota and Wisconsin during a farm visit. All farms in the study used free-flow cow traffic. Mixed model analysis of cross-sectional data showed that farms with automatic feed push-up via a robot produced more milk per AMS/day and per cow/day than farms where feed was pushed up manually. New versus retrofitted facility, freestall surface, manure removal system, and the number of AMS units/pen were not associated with daily milk yield per AMS or per cow. Cow comfort index (calculated as number of cows lying down in stalls divided by total number of cows touching a stall) was positively associated with daily milk yield/cow. Prevalence of lameness and severe lameness, number of cows per full-time employee, depth of the area in front of the AMS milking station, and length of the exit lane from the AMS milking station were not associated with daily milk yield per AMS or per cow. Multivariable mixed model analysis of longitudinal AMS software data collected daily over approximately an 18-mo period from 32 of the farms found a positive association between daily milk yield/AMS and average age of the cows, cow milking frequency, cow milking speed, number of cows/AMS, and daily amount of concentrate feed offered/cow in the AMS. Factors negatively associated with daily milk yield/AMS were number of failed and refused cow visits to the AMS, treatment time (the time spent preparing the udder before milking and applying a teat disinfectant after milking), and amount of residual concentrate feed/cow. Similar results were also found for daily milk yield on a per cow basis; however, as it would be expected, average days in milk of the herd were also negatively associated with daily milk yield/cow. These findings indicate that several management and cow factors must be managed well to optimize AMS productivity.
Key words: automatic milking, robotic milking, milk yield

INTRODUCTION

Since the first commercial automatic milking system (**AMS**) installation on a dairy farm in 1992 in the Netherlands, over 25,000 farms worldwide have adopted this technology (Barkema et al., 2015). The adoption and management of AMS most likely varies throughout the world because of national and regional differences in cost and availability of milking labor, current and future projected dairy herd profit margins, environmental regulations, and the social climate allowing farmers to expand. However, across and within regions, management and facility design can also vary considerably. Implementation of AMS on farms in the Upper Midwest United States (upper central region of the country including the states of Iowa, Minnesota, Michigan, and Wisconsin) has grown in recent years. Farms began installing AMS in the Upper Midwest United States around 2009 and industry estimates indicate that over 400 farms in this region now use AMS (personal communications, various AMS dealers). Milk yield/AMS and milk yield/cow are 2 of the factors that can be used to assess productivity in AMS farms. Research on factors affecting productivity of AMS in this region of the United States is limited.

Housing and management strategies vary greatly within the 2-state region of Minnesota and Wisconsin (Salfer et al., 2018). Several farms retrofit AMS into existing facilities, whereas others build new facilities to install AMS. Limited research has been done evaluating aspects of housing design that might influence milk yield/AMS and milk yield/cow. The presence of a large open area in front of the AMS entrance has been suggested to improve cow flow into and around

Received December 15, 2017.
Accepted April 29, 2018.
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the AMS (Rodenburg and House, 2007). A longer exit lane length was indicated by Jacobs et al. (2012) to potentially be associated with improved cow flow when exiting the AMS due to reduced blocking events by other cows in the pen. However, neither of these factors, which can have economic implications for farmers designing facilities with AMS, has been validated in the field. Limited data exist concerning the practice and frequency of feed push-up. Studies conducted in conventional milking systems by DeVries et al. (2003) and Bach et al. (2008) evaluated pushing up feed up to 4 times/d, which is considerably less frequent than what is achieved with automatic feed push-up systems, where feed is generally pushed up every hour or every other hour.

In addition, limited research has been conducted to analyze daily data recorded by the AMS software from a representative number of AMS farms in the same region over an extended period of time to evaluate factors associated with productivity. Tremblay et al. (2016) evaluated weekly data from a large number of farms from across North America; however, regional differences in climate, management practices, and affordable feed resources may lead to differences in management recommendations for different areas. In addition, previous studies have not included factors such as treatment time, average age of the cows, freestall surface, or manure removal system. Therefore, the objective of this study was to investigate the association of daily milk yield per AMS and per cow with housing, lameness prevalence, and management factors on AMS dairy farms in 2 states of the Upper Midwest United States (Minnesota and Wisconsin). It is expected that results of the study will help optimize use of AMS in dairy farms in the United States or help farmers considering AMS.

MATERIALS AND METHODS

Data on housing, lameness prevalence, and management practices were collected during 1 farm visit from 33 dairy farms in 2 states of the Upper Midwest United States (Minnesota and Wisconsin) followed by remote collection of data from the AMS software for a period of approximately 18 mo (mid-2013 to the end of 2014). All farms in the current study used free-flow cow traffic (i.e., cows were allowed to move between the resting area, AMS unit, and feeding area freely). These farms were estimated (based on dealer information) to represent the majority (>85%) of confinement farms with free-flow traffic AMS in these 2 states at the time of initiation of the current study. Observational data of housing design were collected from each pen where an AMS was used to milk the cows. Twenty-three percent of farms milked recently calved cows (up to a week after calving) in a conventional milking system; those cows and their environment were not included in the current study. Only 1 farm in the current study had Jerseys and all other farms had primarily Holsteins; removing the farm with Jerseys from the data set did not alter any of the analysis results; therefore, the farm was kept in the final data set used for analysis.

Housing design measurements included depth of area in front of the AMS unit (m) and length of the protected lane at the exit of the AMS (m). Other observations included whether the dairy selected to build new facilities or retrofit existing facilities when installing the AMS, number of AMS units installed per pen, what type of freestall surface was used, and what type of manure removal system was used in the AMS pen(s). Freestall surface was categorized as mattresses, deep sand, or waterbeds. Two farms using bedded-pack systems were excluded from the analysis of freestall surface. Manure removal system was categorized as either automatic scraping of alleys, manual scraping, or slatted alley floor with a manure containment pit below the barn. The number of cows/full-time employee (**FTE**) at the time of visit was also collected. This included employees working with the dairy operation and did not include other areas of the farm such as crop production. All lactating cows in the current study were housed in a barn and did not have access to pasture. Number of AMS units was categorized into either 1 AMS unit/pen or >1 AMS unit/pen.

Cow comfort index (**CCI**) was calculated by dividing the number of cows lying in a stall by the number of cows touching a stall (cows lying in the stall plus cows standing with 2 or 4 feet in the stall). This index could not be calculated on 2 farms because they used a bedded-pack housing system (therefore did not have freestalls) and 3 other farms for which this measurement could not be collected. Espejo and Endres (2007) found CCI to be negatively associated with lameness prevalence in a study with conventional freestall farms in Minnesota. Farms in the current study were not overcrowding stalls (mostly at 100%); therefore, stall stocking density was not investigated because there was not enough variation among farms.

A minimum of 30% of cows in all pens as a representative sample of the herd (Endres et al., 2014) were scored for locomotion by a single trained observer using a 5-point scoring method (Flower and Weary, 2006), where 1 = normal, 2 = imperfect locomotion, 3 = lame, and scores of 4 and 5 = severely lame. Cow identifications were recorded by the observer to avoid scoring the same cow more than once; cows were scored by the observer as they walked in the freestall alleys for a minimum of 6 strides without impediment, and

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