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Analysis of milking characteristics in New Zealand dairy cows

J. P. Edwards,*[1] J. G. Jago,* and N. Lopez-Villalobos†
*DairyNZ, Private Bag 3221, Hamilton 3240, New Zealand
†Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Private Bag 11222, Palmerston North 4442, New Zealand

ABSTRACT

The objective of this study was to describe the variation in milking characteristics, and factors associated with these traits, in grazing dairy cows milked without premilking stimulation. Milk yield, duration, and average and maximum milk flow rate data were collected from 38 farms in New Zealand at 2 time points (spring and autumn) during the 2010 to 2011 season. Subsequently, a second data set, allowing the generation of daily milk flow profiles, was collected from 2 farms in the 2011 to 2012 season. Corresponding animal data, such as breed, date of birth, and ancestry information, were extracted from the New Zealand Dairy Industry Good Animal Database (New Zealand Animal Evaluation Ltd., Hamilton, New Zealand). Residual milking duration (deviation from the regression line of milk yield on milking duration) was calculated, allowing the identification of fast-milking cows independent of milk yield. Variance components for the milking characteristics traits were estimated using an animal linear mixed model. The average milk yield was 10 kg/milking and the average milking duration was 360 s. The average milk flow rate was 1.8 kg/min and maximum milk flow 3.3 kg/min, with 44% of milk flow curves being classified as bimodal. Primiparous animals exhibited different milk flow profiles, with a lower maximum flow, than multiparous animals, possibly due to differences in cisternal capacity. Residual milking duration was shortest (−10 s) in mid-lactation (121–180 d) and was 13 s longer for Jersey compared with Friesian cows; however, it was 19 s shorter when adjusted for energy content. Residual milking duration had a negligible genetic correlation (−0.07) with milk yield, indicating that selection for cows with shorter residual milking duration should have a negligible effect on milk yield. A heritability of 0.27 indicated that residual milking duration could be valuable as part of a breeding program. Knowledge of the distribution of milking durations for a given milk yield allows farmers to choose appropriate cluster-on time when using a maximum milking time strategy to improve milking efficiency.
Key words: milk flow profile, milking efficiency, milking speed

INTRODUCTION

The milking facility represents a significant proportion of farm capital investment in pasture-based dairy systems. In addition, a recent study has highlighted that some farmers may have overcapitalized by building parlors that are larger than necessary (Edwards et al., 2013a). Milk harvesting is a labor-intensive task, requiring up to 57% of time annually in pastoral dairy systems (Taylor et al., 2009), which may increase as herd sizes expand (DairyNZ, 2012). Consequently, interest in milking efficiency has been renewed (Edwards et al., 2013c). Improving milking efficiency could increase throughput in existing parlors or, when constructing a new parlor, allow a similar level of throughput to that achieved previously with fewer clusters.

Parlor milking efficiency is strongly influenced by the milking duration of individual cows. Accordingly, research has focused on strategies to reduce the milking duration of cows, such as milking to a predetermined time (Clarke et al., 2004; Jago et al., 2010a,b). In herringbone parlors, the row time is determined by the slowest milking cow, and in rotary parlors the number of bails occupied by cows requiring multiple rotations to complete milking is determined by cow milking duration (Edwards et al., 2012), both influencing parlor throughput. As a longer cow milking duration increases labor costs, it is not surprising that milking speed has been linked to farm profitability and has been included as part of animal breeding programs (Sivarajasingam et al., 1984; Boettcher et al., 1998).

Cow milking duration is determined by milk yield and milk flow rate, which varies during different phases of a milking (Tančin et al., 2006). So, when selecting for cows with shorter milking durations, care is required to ensure that milk yield is not negatively affected, as milking duration has been reported to be positively associated with milk yield (Sandrucci et al., 2007; Gray et al., 2011; Samoré et al., 2011). Likewise, faster-milking

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[1]Corresponding author: Paul.Edwards@dairynz.co.nz

cows have been linked to poorer udder health (Brown et al., 1986; Grindal and Hillerton, 1991; Tančin et al., 2007). Consequently, Berry et al. (2013a) proposed the use of 2 new traits: residual milking duration and residual milking duration including SCC, calculated using the residual of milking duration regressed on milk yield (and SCC). Subjective scores of milking speed are heritable (Meyer and Burnside, 1987; Sewalem et al., 2011). However, in order for these new traits to be useful as part of a breeding program, their genetic correlations and heritabilities require evaluation.

Milk flow curves can be used to determine where differences in broad measures of milking characteristics, such as milking duration, average flow, and maximum flow, may be occurring (Edwards et al., 2013b). Milking characteristics can vary depending on factors such as parity, breed, and stage of lactation (McCarthy et al., 2007; Sandrucci et al., 2007; Walsh et al., 2007). Furthermore, the use of premilking stimulation, present in previous studies, has not been widespread in many pasture-based systems for 40 yr, after work by Phillips (1987) demonstrated that it was no longer required to maximize milk production. However, the effect of a lack of premilking stimulation on milking characteristics and milk flow curves has not been thoroughly explored on animals not accustomed to premilking routines. European studies suggest that cows milked without premilking stimulation are more likely to have bimodal milk flow curves, reducing average milk flow rate and potentially affecting udder health (Bruckmaier and Blum, 1996; Sandrucci et al., 2007). The response to premilking stimulation of cows in New Zealand pastoral systems is reported to be variable (Edwards et al., 2013c); thus, the identification of cows that do not display bimodal milk curves when milked without premilking stimulation may be advantageous.

The objective of this study was to describe the phenotypic variation and genetic correlations in milking characteristics of a strain of cows not accustomed to premilking stimulation. A secondary objective was to determine the relationship between milk yield and expected milking duration. Such information can be used to identify fast-milking animals and assist in making informed decisions on culling, appropriate milking routines, and parlor operation (milking to a predetermined time).

MATERIALS AND METHODS

Data Collection

Participating farms were selected for their ability to record milking data and all were equipped with electronic identification of cows, electronic milk meters, automatic cluster removers (ACR), and herd management software that recorded individual milking events. Farms were located throughout the dairying regions of New Zealand. All had rotary parlors and 4 different milking equipment manufacturers were represented. A data set was collected from approximately 10 milking sessions at 2 time points: in spring (September–November 2010) and in autumn (February–April 2011). A total of 38 farms were used, resulting in milking data from 24,056 spring-calving (July–September) cows. All farms conducted at least 1 herd test during the season where milk composition and SCC data were collected.

The herd management software on each farm was programmed to record similar fields. The variables recorded included cow number, birth identification, electronic identification number, date of birth, milking date, identification (**ID**) time, bail number, milk yield (kg), milking duration (s), average flow (kg/min), maximum flow (kg/min), calving date, and DIM.

Animal data for the 38 farms were extracted from the New Zealand Dairy Industry Good Animal Database [New Zealand Animal Evaluation Ltd. (NZAEL), Hamilton, New Zealand]. Fields extracted included owner participant code, map reference, herd number, animal key, birth ID, birth date, ancestry information, and proportion (in 16ths) of Holstein-Friesian (**F**), Ayrshire, Brown Swiss, Friesian, Guernsey, Jersey (**J**), and milking Shorthorn breed. Additionally, herd test information, such as fat and protein percentages and SCC, were extracted. This data set was merged by cow with the milking data collected on farm. All data manipulations were carried out using SAS (version 9.3; SAS Institute Inc., Cary, NC).

A second data set (detailed data set) was collected from 2 of the farms between September 2011 and May 2012. The dairies were equipped with Metatron S21 milk meters (GEA Farm Technologies GmbH, Bönen, Germany) at every bail. At each milking session, the herd management software (DairyPlan C21; GEA Farm Technologies GmbH) was set up to record cow number, registration number, milking date, milking time, milk yield, milking duration (cluster-on to cluster-off), average milk flow rate (from initiation of milk flow to cluster removal), maximum milk flow rate, time from cluster attachment to maximum milk flow rate, milk yield in the first 2 min, and time from maximum milk flow rate to end of milking. The average milk flow rate was recorded in 15-s intervals up to 4 min, 30-s intervals between 4 and 7 min, and 60-s intervals from 7 to 10 min. Animal data from the relevant time period were extracted from the New Zealand Dairy Industry Good Animal Database (NZAEL) for the 2 herds and matched to corresponding animals from the milking data. Fields extracted included cow number, birth ID,