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Total mixed ration recipe preparation and feeding times for high-milk-yield cows on California dairies

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ABSTRACT

The time to prepare and feed a TMR recipe and how consistently these tasks are performed on commercial operations have not been described. The objective of this study was to provide baseline data by describing within and across dairies the time to prepare and feed the high-producing-cow ration and the time elapsed between ingredient loads during recipe preparation. Twenty-six dairies in California housing 1,100 to 6,900 cows were enrolled. Records from a 12-mo period were extracted from the feeding management software (FeedWatch 7). Interquartile range (IQR: Q_3–Q_1) was used as a measurement of variability. Median recipe load preparation time ranged from 9 min 18 s to 27 min 0 s. Recipe preparation time was relatively consistent (IQR <3 min) on 4 dairies but inconsistent (IQR >6 min) on 3 dairies. Time from recipe preparation to start feeding ranged from 1 min 54 s to 9 min 0 s, with a within-dairy variation (IQR) ranging from 50 s to 10 min 50 s. The median recipe load feeding time ranged from 90 s to 10 min 48 s. Six dairies were relatively consistent (IQR <1 min), but 2 were not (IQR >5 min). The median time elapsed between ingredient loads ranged across dairies from 40 to 84 s. On 8 dairies often (15 to 49%) there were <30 s between ingredient loads; likely, leftover ingredients were not returned to the commodity barn. Consultants and owners can evaluate feed management software records to identify short, lengthy, or variable recipe preparation times relative to our baseline data.

Key words: feed management software, mixing time, total mixed ration

INTRODUCTION

Over the past decades, great progress has been made in understanding nutrient requirements of cattle and in creating ration formulation models. However, there are opportunities to improve feed efficiency on dairies through management (Rossow and Aly, 2013; Sova et al., 2014). The aim of a feed management program is to achieve a TMR that (1) is formulated to meet the nutrient requirements of dairy cattle, (2) is correctly mixed to provide a homogeneous nutrient supply to all cows, (3) has an optimal particle length that favors rumen function but prevents sorting, (4) includes only unspoiled ingredients, and (5) is consistently available at the feed bunk for optimum health and production.

Several authors (Zinn, 2004; Biermann, 2009; Buckmaster et al., 2014) have suggested that mixing time is one of the variables that affects feed bunk uniformity and TMR particle length, along with recipe type (physical properties of ingredients, order of ingredients, load size, number of ingredients) and mixer box characteristics (type, brand, horsepower, presence of buildup and worn parts). The optimal mixing time of a TMR recipe is variable because it is a function of both recipe type and characteristics of the mixing equipment. If mixing time is too short, hay could end up being improperly processed, promoting sorting behavior (Leonardi and Armentano, 2003; Devries et al., 2008) and thereby affecting milk yield and milk components (Oelberg and Stone, 2014). This is especially relevant for recipes that include unprocessed hay. To improve feed bunk uniformity, Kammel et al. (2012) proposed loading hay slowly and allowing extra mixing time before adding the next ingredient. Nevertheless, overmixing may end up favoring segregation of some ingredients and excessively reducing the particle length of forages (Kammel et al., 2012). It has been suggested that a recipe load should be mixed for 3 to 5 min after the last ingredient is added to achieve a good mixing uniformity (Oelberg and Stone, 2014). However, in a 2009 feeding management survey, dairy operations in California reported mixing times ranging from 3 to 35 min (Silva-del-Río et al., 2010).

Dairies that use a feed management software (**FMS**) can track loading and delivery times of TMR recipes. Currently, FMS are not designed to capture information on the activity of the mixer box. However, on most dairies mixing starts as soon as the first ingredient is added and in many instances continues until feed is delivered. The objective of this study was to provide baseline data by describing within and across dairies the time to prepare and

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feed the high-producing-cow ration (**HCR**) and the time elapsed between ingredient loads during recipe preparation.

MATERIALS AND METHODS

Data Collection and Dairies

Twenty-six California dairy cattle farms using FeedWatch 7 (Valley Agricultural Software Inc., Tulare, CA) as their FMS for at least 1 yr were enrolled in the study. A 12-mo data backup was obtained from the FMS for each farm. The final data set included information from Jan 2012 to May 2014. California dairy nutrition consultants and Valley Agricultural Software Inc. personnel assisted with identifying dairies to participate in the study. Enrolled dairies were located in the San Joaquin Valley, ranging in size (lactating and dry cows) from 1,100 to 6,900 cows. Each dairy was given a number according to its herd size, from largest (dairy 1) to smallest (dairy 26). Dairies 1 to 6 had more than 4,000 cows, dairies 7 to 20 had between 2,000 and 4,000 cows, and dairies 21 to 26 had fewer than 2,000 cows.

Records were extracted only from the HCR to standardize data interpretation across dairies. The number of recipe loads prepared per day [median (range)] was 6 (2 to 14), the number of ingredients per recipe was 8 (4 to 10), the recipe load weight was 10,000 kg (4,800 to 18,000 kg), the number of feeders registered in the FMS was 4 (1 to 6), the number of pens fed HCR was 8 (3 to 32), and the number of cows per pen was 206 (69 to 395).

Assembly and Structure of the Data Set

The consultant version of FeedWatch 7 was used to extract records from the setup function and user reports. The following records were obtained: date, recipe load number, feeding sequence, start loading time, end loading time, start feeding time, feeding tolerance level, end feeding time, and ingredient type. Time records were extracted from the FMS in military format (hh:min:ss a.m./p.m.) and imported into a Microsoft Excel file for conversion into a 24-h configuration. A description of the variables obtained from the FMS is shown below.

Recipe Load Number. The number that identifies each recipe load.

Start Loading Time. The FMS registers the start loading time of an ingredient only after the minimum scale detection weight is reached. The minimum scale detection weight is set on the FMS so that the mixer scale does not read small weight changes that could be associated with bouncing during mixing or driving.

Loading Tolerance Level. To avoid overloading ingredients, the FMS assigns a tolerance level (**TL**) to each commodity. When the amount of feed left to reach the formulated target is equal to or less than the assigned TL, the FMS asks for the next ingredient to be loaded. After reaching the TL, if there is a pause of 5 s or longer, the FMS will register the new weight as the next ingredient of the recipe.

End Loading Time. The FMS registers the end of loading time for an ingredient when the scale does not read any new weight for at least 5 s once the target weight set by the loading TL has been reached.

Start Feeding Time. The FMS registers the start of feeding when the mixer box doors are opened and feed is pushed out into the feed bunk.

Feeding Tolerance Level. To avoid excessive feed delivery to a pen, the FMS assigns a feeding TL per pen. When the amount delivered to a pen is equal to or less than the assigned feeding TL, the FMS asks to deliver feed to a different pen.

End Feeding Time. The FMS registers the end of a recipe load feeding by pen when the scale does not read any new weight for at least 5 s once the target weight set by the feeding TL has been reached.

Ingredient Type. There were 33 different ingredients used in HCR recipes across all dairies. The 8 most common ingredients represented 63.1% of the total observations and were fed on at least half of the dairies: premix (n = 26), alfalfa hay (n = 26), corn silage (n = 26), liquids (n = 20), rolled corn (n = 19), almond hulls (n = 15), wet distiller grains (n = 14), and wheat silage (n = 14). Data presented by ingredient type included only information from these 8 ingredients.

Calculations

Recipe Load Preparation Time. This is the time elapsed from the start loading time of the first recipe load ingredient to the end loading time of the last recipe load ingredient.

Time from Last Ingredient Loaded to Feeding. This is the time elapsed from the end of recipe load preparation to the start of feeding. During this time, the feeder can be mixing a recipe load, driving to reach the feed bunk, or both.

Feeding Time. This is the time elapsed from the start feeding time of the first pen to the end feeding time of the last pen fed for the same recipe load.

Time from Start of Recipe Preparation to End of Feeding. This is the sum of recipe load preparation time, time from last ingredient loaded to feeding, and feeding time. If the mixer box is operating from the start of recipe preparation to the end of feeding, this variable will represent the total recipe mixing time.

Loading Time per Ingredient Type. This is the time that it takes to load each ingredient from start to end loading time. It was calculated for the 8 most common ingredients of the HCR recipe (premix, alfalfa hay, corn silage, liquids, rolled corn, almond hulls, wet distiller grains, and wheat silage).

Alfalfa Hay Loading Time. This was calculated as the time elapsed from the start loading time for alfalfa hay to the start loading time for the next ingredient. Thus,

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