The Professional Animal Scientist 34:148–155
https://doi.org/10.15232/pas.2017-01704

ARPAS
AMERICAN REGISTRY OF PROFESSIONAL ANIMAL SCIENTISTS

Sources of variation in corn silage and total mixed rations of commercial dairy farms

Paula Turiello,*[1] PAS, Alejandro Larriestra,† Fernando Bargo,‡ Alejandro Relling,§ PAS, and William Weiss,§ PAS

*Departamento de Producción Animal, and †Departamento de Patología Animal, Universidad Nacional de Río Cuarto, Río Cuarto 5800, Argentina; ‡Facultad de Agronomía, Universidad de Buenos Aires, Buenos Aires 1417, Argentina; and §Department of Animal Sciences, The Ohio State University, Wooster 44691

ABSTRACT

Information on sources of variation in feed and diet characteristics is needed to develop appropriate strategies to reduce uncertainty and to separate true variation from that associated with measurements. The objectives were to determine sources of variation in DM content and particle size distribution in corn silage (CS) and TMR. Ten dairy farms in Argentina were visited on 3 consecutive days, samples of CS and TMR were taken, and an audit of feed management was conducted. Corn silage and TMR were sampled in duplicate each day. Variance components were calculated with the Mixed Linear Models of InfoStat for CS and Generalized Linear Mixed Models for TMR. For CS, the model included the effects of farm and day within farm, and for TMR, the model included farm, pen within farm, day within pen, and feed bunk site within pen. Residual effects accounted for sampling and analytical variation. Farm was the greatest source of variation for DM and particle size distribution of CS and TMR, explaining 40 to 92% of total variation. For CS, day within farm variation was greater compared with residual variation in DM (7 and 0.6%, respectively), meaning real changes occurred from one day to the other. For TMR, daily variation in DM content was high and possibly associated with feed management errors. For particle size distribution in TMR, sampling and assaying variation was greater than feed bunk site variation, indicating increased replication and averaging is needed to increase precision.

Key words: variation, dry matter, particle size distribution, total mixed ration

INTRODUCTION

Feed cost is the largest single expense in a dairy farm. Despite the development of accurate models to predict cow performance based on diet formulations, some issues involving sampling and feed analysis, and mixing and delivering the TMR, generate uncertainty regarding the composition of the ration actually delivered to a pen (St-Pierre and Weiss, 2015; Trillo et al., 2016). This uncertainty could lead to over- or underfeeding of nutrients and potentially have environmental and economic costs (St-Pierre and Weiss, 2015). Diet evaluation can also be difficult because of unknown variation in the physical and nutritional composition of TMR (Barmore, 2002).

The DM content of feeds determines the amount of nutrients being offered to the animals, and as ingredients are loaded according to weight, their moisture content is crucial in determining diet formulation and actual nutrient composition. The distribution of particle size (**PS**) in the TMR affects sorting behavior, which affects nutrient composition of the feed actually eaten by the cow (Kononoff et al., 2003b). These 2 variables are usually recommended as on-farm measurements to provide an indicator to monitor TMR consistency (Amaral-Phillips et al., 2001; Barmore and Bethard, 2005; Oelberg and Stone, 2014).

Inconsistency in the nutrient composition and PS of the TMR could affect cows. Day-to-day variation in nutrient composition of TMR had no or only minor effects on production measures in randomized, controlled studies (McBeth et al., 2013; Weiss et al., 2013; Yoder et al., 2013). However, observational studies found that herds that had greater variation in NE_l and PS in the ration fed to the cows had reduced milk yields and feed efficiency (Sova et al., 2014), and variation in concentrations of certain nutrients was positively correlated with variation in milk yields and composition (Rossow and Aly, 2013).

However, because of the experimental design, the variation in TMR composition and PS in those studies (Rossow and Aly, 2013; Sova et al., 2014) included sampling and analytical variation in addition to true day-to-day variation. Quantifying sources of variation in TMR composition and PS will aid interpretation of studies on the effects of variation and determine whether true day-to-day variation is indeed a concern. Specifically, changes in DM content in forages, such as corn silage (**CS**), could alter TMR nutrient composition and, therefore, cow performance if the ration is not adjusted for those changes. Our objectives

The authors declare no conflict of interest.

[1]Corresponding author: mpturiello@ayv.unrc.edu.ar

Table 1. Farm characteristics[1]

Farm	Lactating cows	Lactating pens	Daily milk production (kg)	Added water in TMR	Mixer design
1	310	4	6,000	No	Horizontal
2	390	5	10,700	Yes	Horizontal
3	100	3	2,500	No	Horizontal
4	310	4	7,600	Yes	Vertical
5	125	2	3,000	No	Horizontal
6	147	3	4,200	No	Vertical
7	290	3	6,600	No	Vertical
8	380	3	9,000	Yes	Horizontal
9	380	5	10,500	Yes	Vertical
10	350	5	9,500	Yes	Horizontal

[1]A total of 10 farms were evaluated in this study. Note that not every lactating pen was enrolled in the study.

were to determine and quantify the sources of variation (farm, day, sampling + analytical) in DM content and PS distribution of CS and TMR in 10 commercial dairy farms in Córdoba, Argentina.

MATERIALS AND METHODS

Farm Characteristics

This study was conducted under the regulations of the committee of research ethics of Universidad Nacional de Río Cuarto. Ten dairy farms in southern Córdoba Province, Argentina (33.1244019 S, 64.3772949 W), feeding a TMR to their lactating cows were enrolled in this study (Table 1). Dairy farms were visited on 3 consecutive days during the summer of 2015 (February 5 to April 21), and an audit on feed management and facilities was conducted in each farm. The average size of farms was 270 lactating cows, ranging from 100 to 390 cows. Average individual milk yield ranged from 19.4 to 28.6 kg/d. Only one dairy farm had concrete feed bunks with headlocks, whereas the other dairy farms had wooden, canvas, plastic, or metal feed bunks with access from both sides. In one farm, the feeder cleaned out the feed bunks daily; in the rest, the manager or producer expressed that they did it irregularly according to their needs. All farms included CS in lactating cow diets. Seven farms stored CS in piles and the rest in bags. Of all farms, 90% fed ground corn, alfalfa hay, and soybean meal, and 70% fed at least one wet ingredient (distillers, brewers, or high-moisture corn) to their lactating cows (Table 2). Half of the dairy farms added water (3 to 36% of as-fed TMR) when preparing the ration in the mixer. Across all TMR preparations, residual TMR in the mixer wagon was usually found and considered as a source of variation contributing to pen, day, and feed bunk site variation in TMR offered to the cows. Farms had 1 or 2 feeders, but they only had one person primarily responsible for TMR preparation. Across all farms, 60% of the feeders were never formally trained in mixer wagon use and TMR preparations.

Sampling and Analysis

During each of the 3-d sampling periods, farms were visited daily during the morning when the first TMR was prepared and delivered to the lactating dairy cows. If feed bunks had residual feed in them, they were not cleaned out before sampling in an effort to not interfere with normal feed bunk management. The TMR was sampled im-

Table 2. Ingredient composition of TMR from 27 pens on 10 dairy farms[1]

Ingredient	No. of pens	Inclusion rate (mean ± SD, %)	Range[2] (%)
Corn silage	27	35.7 ± 10.9	15.2–57.9
Hay-crop silage	9	23.1 ± 18.7	4.6–53.9
Alfalfa hay	24	14.5 ± 6.2	4.9–25.7
Corn grain	24	23.5 ± 8.5	3.4–36.4
Soybean meal	24	12.5 ± 4.3	5.3–21.8
Wet by-products[3]	14	10.4 ± 3.5	4.9–16.0
Dry by-products[4]	8	21.1 ± 13.7	7.3–39.5
Water	14	16.2 ± 11.4	3.0–36.0

[1]A total of 10 farms and 27 pens within farms were evaluated in terms of number of pens that included each ingredient in their TMR, mean inclusion rate, and range of inclusion in those pens using the ingredient.

[2]Range of inclusion of each ingredient in those pens using that feed.

[3]Wet by-products included wet distillers grains with solubles, high-moisture corn, and brewers grains.

[4]Dry by-products included soybean hulls, whole cottonseed, and sunflower meal.