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# **TMR Audits Improve TMR Consistency**

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## **Introduction:**

A consistent healthy rumen environment every day for every cow on a dairy is perhaps one of the greatest success factors to a dairy's financial well-being. However, can the dairy maintain a consistent healthy rumen environment every day for every cow? The answer is usually no because there are so many factors that can affect the rumen environments of all of the cows on the dairy. The easiest way to understand this is to consider all of the factors that can affect dry matter intake. These factors include weather, calving, pen moves, ration changes, moisture changes in wet feeds, mold and wild yeast levels in wet feeds, sorting, crowding and improper treatment of animals and finally inconsistent TMRs.

Diamond V personnel started investigating factors affecting TMR consistency in January 2008 on large dairies in the Upper Midwest and across the U.S. We soon called this investigative process the TMR Audit<sup>TM</sup>. A TMR Audit<sup>TM</sup> is an on-farm evaluation of the feed storage and preparation, mixing and delivery of the TMR, ingredient variation and shrink and utilization of labor and resources. It is designed to reduce variation in the TMR and improve the efficiency of the feeding operation. Many of the key factors affecting TMR consistency will be discussed in this paper.

## **Materials and Methods:**

TMR samples were obtained along the feed bunk immediately after delivery before the cattle begin eating and sorting. Ten spot samples per load were taken at equally spaced

positions along the bunk. The sampling positions were determined by counting the number of posts supporting the free stalls and then dividing that number by ten. A one-cup measuring scoop was used to collect enough material to fill a quart-sized plastic bag that could be zipped shut to exclude air. Samples were placed in a 5-gallon pail until particle separation analysis using the Penn State Shaker box (two screens and pan). TMR was scooped from the bottom, middle and top of the windrow of TMR at each sampling location. Backup samples were sometimes taken and tested for moisture, crude protein, starch, ADF, NDF and ash using NIR analysis by Dairyland Labs.

Samples of weigh backs were obtained by taking 5 spot samples along the bunk associated with each pen and placing into a quart-sized plastic bag. Particle size analysis using the Penn State shaker box was used to compare weigh backs to the original TMR and determine the extent of sorting.

Coefficients of variation were determined on the top, middle and bottom screens for each load of TMR or on the NIR nutrient analysis using the method of Herrman and Behnke<sup>1</sup>. Because of the large variation seen in the top screen for lactation rations, we used only coefficients of variation for the middle and bottom pan of the Penn State Shaker box to assess TMR consistency. The top screen, middle and bottom pan can be used to assess dry cow and replacement heifer rations because the percentage on the top screen is usually close to 30%.

Coefficients of variation of 1 to 2% are often seen when mixing conditions of the wagon are excellent and coefficients of variation of 3 to 5% are good indicating no apparent problems with TMR mixing. Coefficients of variation above 5% can indicate a variation of problems such as overfilling, under mixing the last added ingredient, worn mixer augers, improper loading of ingredients, inadequate loading order of ingredients and poorly processed low-quality hay.

In addition to the Penn State Shaker box, other tools used during TMR audits are stop watches, grain sieves, digital cameras

with video capability and an infrared camera. The infrared camera can show heating of feeds and TMR.

The TMR audit basically follows the feeder's steps in making a TMR which include reading weigh back levels, facing silage, getting mixing equipment ready, and finally loading, mixing and delivering the TMRs. Photos, videos notes and TMR samples are taken and all of the information is put into a PowerPoint presentation that is shared with the feed management team at the end of the audit. Diamond V has conducted over 450 audits across the U.S. since January 2008.

## **Results:**

### **Spot sampling vs. quarter sampling.**

Diamond V personnel conducted a TMR mixing study on a large commercial dairy in the Upper Midwest in February 2010 and showed no difference in the coefficients of variation between samples taken from the same load of TMR using the spot sampling method vs. quarter sampling method. There were ten spot samples and ten quarter samples. Quarter samples were obtained by scooping the entire cross sectional area of the windrow of TMR in the feed bunk with a scoop shovel. The material was piled on a 4-foot square piece of smooth plywood. The pile was turned several times and quartered into 4 sections with the shovel. Two alternate quarters were discarded and the remaining two were mixed. This procedure was repeated until the remaining material could fit into a quart-sized plastic bag. A marker<sup>3</sup> was used to measure mixing performance and the coefficients of variation (20%) for the marker was similar between the two sampling methods. This variation was higher than expected as it was part of a larger study looking at the effect of ingredient inclusion level on mixer performance. Spot sampling has been our preferred method of sampling because it is much faster and takes less labor to collect samples before the cows consume a significant portion of the diet immediately after delivery.

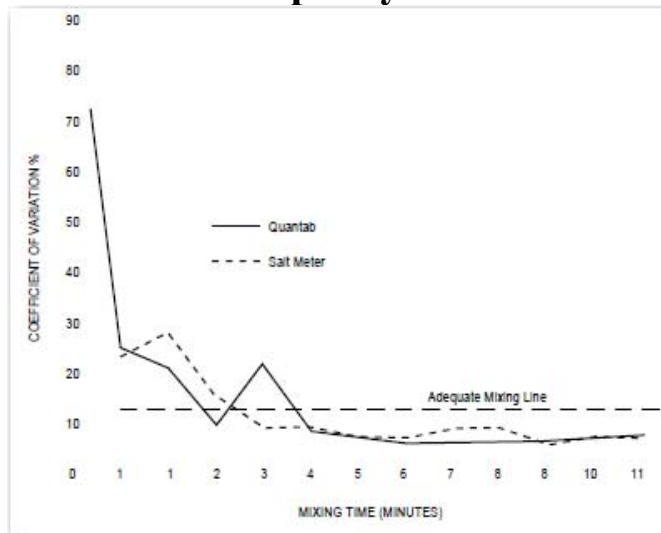
## Discussion:

### Factors affecting TMR consistency

#### Under mixing

Adequate mixing time is very important for obtaining consistent TMRs. Figure 1 shows the relationship between coefficient of variation of salt content in a meal type ration and mixing time. A complete mix was obtained after 5 minutes of mixing when the coefficient of variation in salt content of the ration reached 10% or less<sup>2</sup>. Under mixing the last ingredient added to a TMR is one of the most common mistakes we see on dairy farms. Three to five minutes is usually needed to get a complete mix, but often we only see 30 to 60 seconds of mix time. Also, as the augers wear inside the wagons mix time needs to be increased to get the TMR completely mixed. However this is often ignored and we see inconsistent TMRs with worn equipment.

**Figure 1. Two-ton capacity drum mixer rotating at 3 r.p.m.**



#### Overfilling

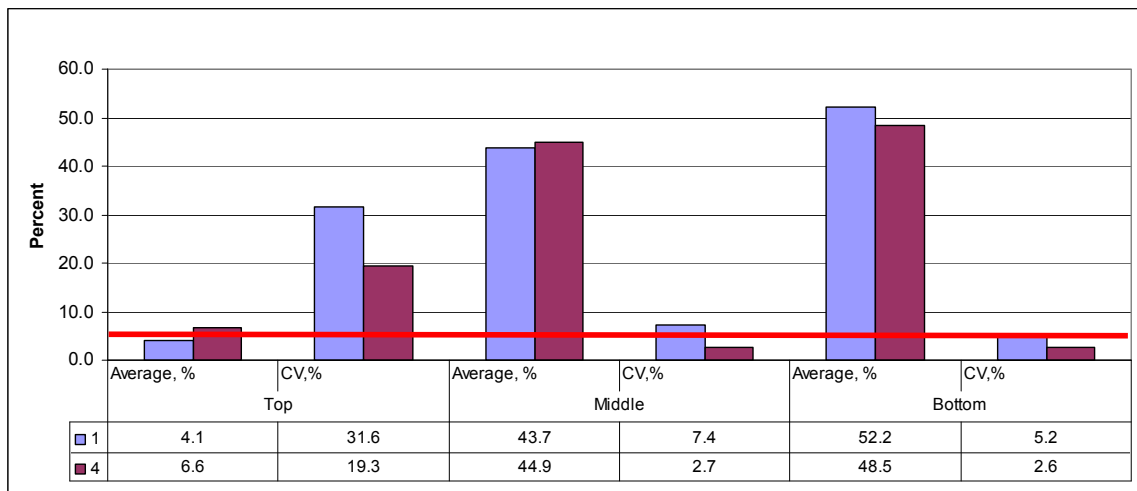
Over filling the TMR wagon is another big reason why we see inconsistent TMRs. Figure 2 shows a horizontal wagon filled past the top of the metal box. When the load size was reduced from 23,000 to 18,000 lbs of a lactation mix there was a reduction in the coefficients of variation as shown in Figure 3. Figure 4

shows more variation in dry matter, crude protein, starch and ash in a lactation TMR from a TMR wagon that was over-filled compared to the very next load that was not over-filled.

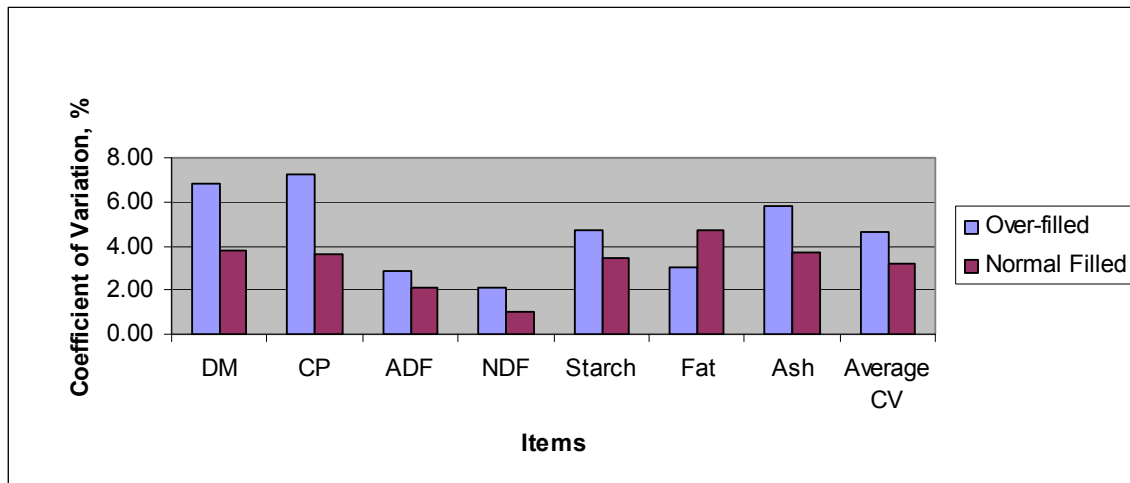
**Figure 2. Over-filled Mono-Mixer Model 2090.**



**Figure 3. Penn State shaker box levels and coefficients of variation for over-filled and normal filled Mono-Mixer wagon.**



**Figure 4. Coefficients of variation in nutrients with an over-filled and normal filled auger-reel horizontal TMR mixer.**



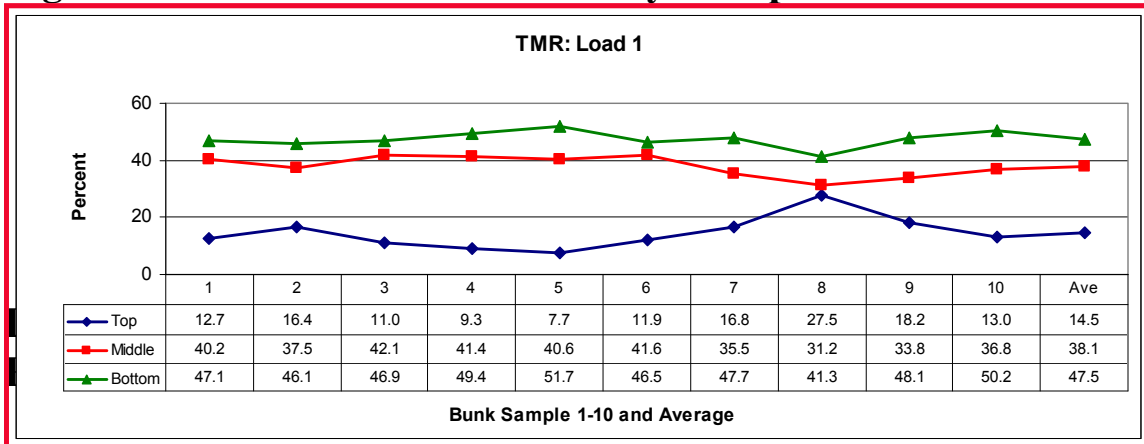
### **Ingredient Load Order**

There is no consistent recommendation on ingredient load order but it depends on the type of wagon (vertical vs. horizontal), level and type of hay (chopped vs. round bales or squares) and feeder experiences with mixing TMRs. Many times we will see clumps of hay, haylage or high-moisture corn in the TMR. Often times moving these items up in the load order while the mixer is running will allow more processing time to reduce these clumps and make the TMR more consistent. Figure 5 shows a clump of hay in lactation TMR and figure 6 shows a very inconsistent TMR as determined by shaking ten samples through the Penn State shaker box. Figure 7 shows an improvement in the consistency of the TMR after the hay was added earlier in TMR mix and allowed to blend with the haylage in a 4-auger wagon.

**Figure 5. Hay clump**

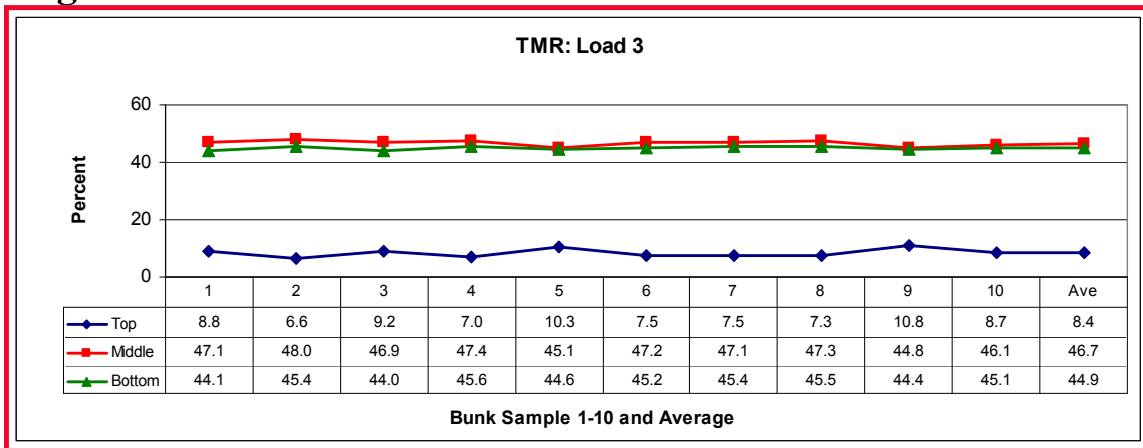


**Figure 6. A lactation TMR with hay clumps.**





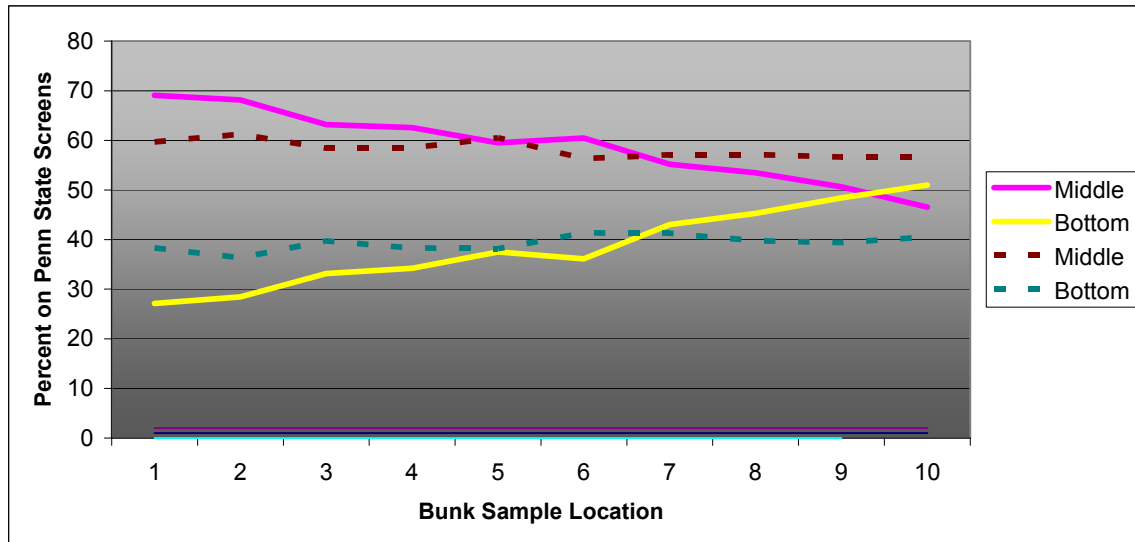
**Figure 7. Lactation TMR shown in figure 6, but hay added earlier in the mix behind haylage in a 4-auger horizontal wagon.**



### **Proper loading of liquids**

Liquids added TMR is one of the most important ways to reduce sorting. However, care is needed how the liquids are added and mixed into the TMR to maintain consistency. Figure 8 shows a dramatic improvement in TMR consistency as measured by particle size in a Penn State shaker box. There was consistency in the TMR particle size as showed by the dotted lines. The milk production of the herd went up about two pounds within 7 to 10 days after the herd started added and mixing the liquid correctly.

**Figure 8. Penn State shaker box results of a TMR with liquid added properly (dotted lines) and improperly (solid lines) to a twin-screw vertical wagon.**



The key messages are as follows:

- **Maintaining a consistent healthy rumen every day for every cow on the dairy is a key to financial success**
- **The TMR on paper often is not the one that all cows eat**
- **The Diamond V TMR Audit™ has identified key factors as to why the TMR on paper does not match the one consumed by the cows**
- **As a dairy consultant you have the opportunity to help your clients find solutions to TMR inconsistencies and to guide them to use research proven products that provide good returns on the investment.**
- **Use Diamond V as an insurance policy to keep the rumen functioning and healthy every day for every cow on the dairy**

## **References:**

1. Herrman T and Behnke, K. 1994. Testing Mixer Performance. Kansas State University. MF-1172.
2. Harner JP, III, Behnke K, and Herrman T. 1995. Rotating Drum Mixers. Kansas State University. MF2053.
3. Eisenberg. D. Micro-Tracers, Inc. San Francisco, CA 94124.