BUNK MANAGEMENT STRATEGIES TO REDUCE TMR SORTING

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Today's high producing dairy cow requires a minimum amount of dietary, physically effective fiber for optimal rumen function, proper chewing activity, saliva production and fiber mat formation in the rumen. A lack of effective fiber intake by the dairy cow can result in subclinical acidosis that is characterized by one or more of the following disorders:

- Increased incidence of displaced abomasums
- Decreased cud chewing activity
- Feed intake fluctuations & digestive upsets
- Depressed immune function
- Milk fat depression
- Foot disorders (laminitis, white line disease, etc.)

During the past number of years, dairy management consultants and producers have utilized particle size separation boxes to determine the distribution of forage and TMR particle size. The results of a forage and TMR particle size distribution analysis is a valuable tool in formulating high energy rations and troubleshooting effective fiber intake challenges.

Recommendations have been established for particle size distribution of forages and TMR's for optimal performance and health of the dairy cow. These recommendations have included the particle size distribution at the time of forage harvesting and TMR feeding. In addition, it has been well documented the negative effects of overmixing of TMR's on the reduction of particle length and subsequent effective fiber intake. These effects are classified as management effects on forage and TMR particle length.

One area that has not been closely evaluated is the "cow effect" on effective fiber intake. In other words, are cows capable of sorting out the effective fiber portion of the TMR diet and is this an important consideration in troubleshooting effective fiber challenges on dairy farms?

ON-FARM EXPERIMENTS

A series of on-farm experiments was conducted using the Penn State Particle Size Separator to determine the degree of TMR sorting or selective consumption that occurs in typical dairy rations. The initial farm trial utilized a well-managed dairy utilizing a 1 group TMR fed 1 time per day. At feeding, the TMR met the particle size separator requirements for particle size distribution (table 1).

Table 1. Particle Size Separator Distribution at Feeding

Particle Size Separator	Distribution	Goal
Top	9.3%	7-12%
Middle	47.0%	30-50%
Bottom	43.7%	< 50%

Every 6 hours postfeeding, the remaining TMR was pushed up and sampled to determine changes in the particle size profile of the TMR. If no sorting or selective consumption was occurring, the particle size distribution should not change. However, samples taken at 6 hour time intervals showed a major cow effect on sorting of TMR particle sizes. In this trial, cows selectively consumed the finer particles and selected against the longer “effective fiber” particles (table 2).

Table 2. Shaker Box Analysis - 6 Hour Intervals

	Time				
	0 hr.	6 hr.	12 hr.	18 hr.	23.5 hr.
Top	9.3	13.7	21.5	27.5	58.7
Middle	47.0	42.3	41.6	38.9	26.7
Bottom	43.7	44.0	36.8	33.3	14.5

* Each sample was measured in triplicate.
* Standard deviation of the mean and coefficient of variation (<5%) was very low indicating confidence in these numbers.

From this particle size distribution data, we could calculate the type of “physically effective” diet the cows were consuming during each 6 hour time interval. If there was no sorting occurring, each cow should have consumed 9.3# of long fiber (100# feed intake x 9.3% top screen = 9.3#) and this long fiber intake should have been evenly distributed throughout the 24 hour feeding period. However, due to sorting, this herd did not consumed the recommended amount of long fiber (6.8# vs 9.3#) and the diet consumed during the first 12 hours of the feeding period had minimal top screen effective fiber intake (table 3). Based on this data, this diet could be a risk factor for subclinical acidosis.

Table 3. Long Particle Intake Data

Time	Feed Consumed, lb.	Actual Long Particle Consumed, lb.	Predicted Intake, lb.	Ration Profile, % of Top Screen
9 am - 3 pm	36	0.35	3.35	0.97 %
3 pm - 9 pm	27	0.42	2.50	1.55 %
9 pm - 3 am	17	2.08	1.58	12.20 %
3 am - 8:30 am	20	4.02	1.87	20.00 %
	100	6.87	9.30	
		73.8 % of Predicted		

Figure 1. Photos of TMR - 6 Hour Intervals

O hr.

6 hr.

12 hr.

18 hr.

23 hr.

When feeding dairy cows, there are "3 rations" that must be closely evaluated to ensure feeding success:

- Ration formulated on paper
- Ration that is mixed and fed
- Ration that is actually consumed

In this situation, the ration was formulated correctly, mixed correctly and had the recommended particle size profile when fed. However, the ration was not consumed correctly due to the physical characteristics of the feed ingredients.

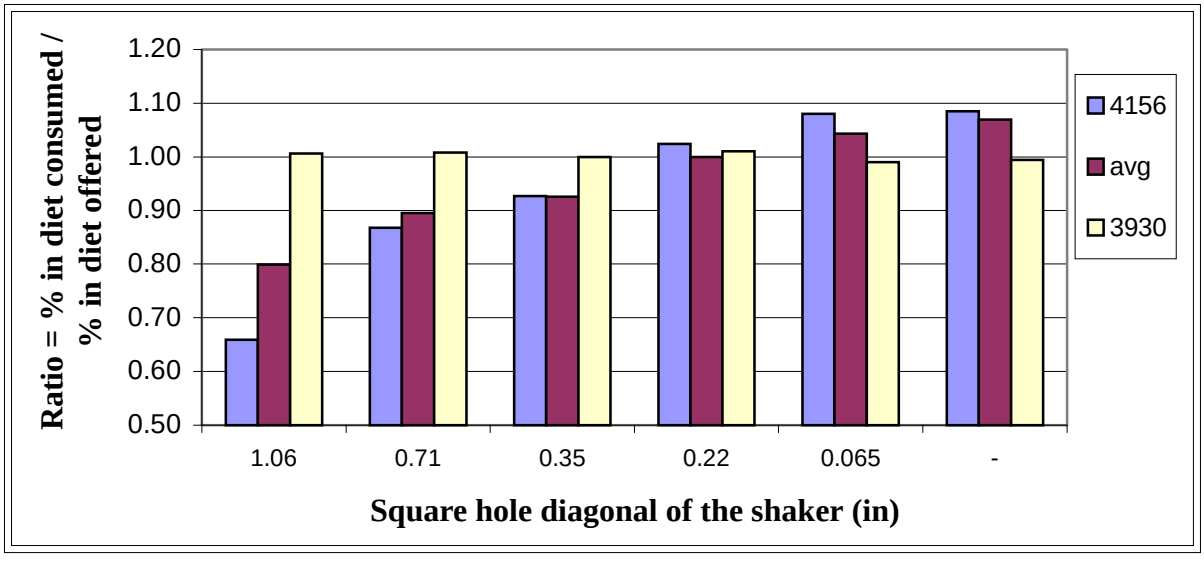
UNIVERSITY RESEARCH

During the spring of 1999 a trial was conducted at the University of Wisconsin-Madison's Arlington research station, to investigate the variation among lactating dairy cows in sorting.We also measured the effect of different amounts, quality and particle size of hay in the diet. The six diets fed consisted of 60% grain and 40% forage, two diets had 40% alfalfa hay and the other four diets had 20% hay and 20% alfalfa silage. The dry matter of the hay only diets was 89.9% and 69.4% for the 4 diets with hay silage. To measure individual cow eating behavior animals were housed in individual stalls. Every one of the 24 cows in the trial received each of the six diets.

A six-screen shaker defined particle size in this experiment rather than the simpler shaker box commonly used in the field. Figure 2 shows sorting behavior for each of 6 particle size fractions, with the longest particles on the left. Sorting is expressed as the ratio: percentage of a given particle size in the feed actually consumed divided by the percentage of that same particle size in the TMR offered. A ratio of 1 indicates no sorting. Particle sizes with a ratio below 1 are being avoided and above 1 are being selected by the cows. On average (middle bar in each group of three) cows sort against the longest particles (ratio= .80) and select for the finest (ratio= 1.07). Note that cows sort the coarsest particles more than the next coarsest particles. The two top screens of the Wisconsin shaker are roughly equal to the top screen of the Penn State shaker, so the long particles on the Penn State top screen will be sorted more then the shorter particles on the same screen. Cow 4156 is an example of a cow that sorted extensively and cow 3930 essentially did not sort. It is important to realize that when sorting is observed in a freestall group, there are likely cows in that group sorting much more than 'average'.

In this trial, varying hay quality from 35% NDF to 45% NDF did not cause any differences in sorting behavior. There was clearly more sorting when cows were fed the driest diets, for which the average ratio for the longest particles was .60 compared to .89 when feeding the wetter diets. When you combine the effect of a cow that sorts more than average with the dry diets that were sorted extensively there was one case where a cow didn't eat any of the very longest particles (ratio=0!).

Figure 2. Data Averaged Among the Six Treatements and the 24 Cows, One Example of High and One of No Sorting Cows.



Based on the university data and field observations, the following factors were determined to be risk factors for TMR sorting or selective consumption:

- TMR Moisture Level: Correct moisture is important to hold feed particles together. Goal: 46-52% Dry Matter
- Amount of Dry Hay Fed: Higher levels of dry hay in combination with poor quality can contribute to TMR sorting. Lower amounts (2-4#), high quality and processing hay to reduce particle length are important.
- Consistency of TMR Particle Size: Longer particle feeds added to the TMR will promote sorting. Goal is to have adequate particle length but consistent particle length of the TMR.
- Corn Silage Processing: Processing of the husks and cobs in the TMR that can promote sorting.

FOLLOW-UP EXPERIMENTS

Based on the identification of these risk factors, follow up farm experiments were conducted to evaluate 4 different TMR rations that minimized these sorting risk factors. The key characteristics of these 4 diets were:

- Processed corn silage
- No dry hay or less than 4# per head
- Consistent TMR particle size
- Correct TMR moisture level

Bunk evaluation of these 4 diets showed improved and correct effective fiber intake. Top screen effective fiber intake ranged from 90-98% of expected intake which was excellent. We still did see a certain degree of sorting, however it was not severe enough to negatively affect overall effective fiber intake.

BUNK MANAGEMENT CONSIDERATIONS

Our understanding of the dairy cow's ability to sort out and consume the finer feed particles of the TMR at the expense of long fiber intake may require us to re-think our standard bunk management recommendations. It is important to understand that these standard bunk management recommendations are not wrong, but may need to be adjusted in order to deal with TMR sorting issues.

Bunk Management Recommendation #1

Feed To 5-10% Leftovers: It is well known that to maximize milk production, you need to maximize dry matter intake. Many dairy operations will mix and feed their TMR once per day, push up feed multiple times, and feed to 5-10% leftovers in order to maximize intake. However, this may not be the right recommendation if the diet is susceptible to sorting. For example, a cow may consume 100# as-fed feed per day with 6# leftovers. If the 6# that is not consumed is composed of the long, physically effective portion of the diet, this may not meet effective fiber

requirements for optimal performance of the dairy cow. It is important to maximize dry matter intake but not at the expense of correct effective fiber intake.

You need consider this question: Which is better??? A 51# dry matter intake with no leftover TMR and the entire effective fiber consumed or a 52.5# dry matter intake with a selectively consumed, higher concentrate ration (Figure 3).

Figure 3. Bunk Management

Feed to 6 % Leftovers

Feed to 0 % Leftovers

Our recommendation is to feed and manage to maximize intake but if the TMR is susceptible to sorting you need to consider feeding multiple times per day with the ration totally consumed at each feeding.You may also consider mixing once per day and split feed that mix at different times of the day. In addition, when feeding to 0% leftovers, be sure that there is feed in front of the cows 20-22 out of the 24 hours in a day. Remember that feeding to maximum intake and minimal leftovers takes excellent management and record keeping to achieve the optimal results.

Bunk Management Recommendation #2:

Do Not Feed Hay Outside The TMR: In general, this is a correct recommendation. However, if cows are sorting out the hay in the TMR and not consuming it, this may not be a good recommendation. Nutrition consultants have long recommended to avoid feeding hay outside the TMR because it then will not be a "true" TMR. However, if cows are sorting, it is not a true TMR either. When feeding hay in the TMR and to minimize sorting, you need to take into account 3 factors: Amount, Quality and Particle Length.

- **Amount:** It appears that adding more hay to the TMR increasing the likelihood of sorting. You may be able to obtain better results with less hay and still provide adequate effective fiber intake. This is a paradox since it is commonly recommended to add more hay to the diet in order to improve rumen function and prevent subclinical acidosis. Adding more hay may have the opposite effect since higher levels of hay in the TMR decrease moisture level and provides more opportunity for sorting.

- **Quality:** High quality hay is critical in order to insure mixability and palatability of the mix. Low quality, course hay that does not mix well will promote sorting and result in inadequate effective fiber intake.

- **Particle Size:** Processing the hay into a shorter particle length will create a more uniform mix and reduce the cow's ability to push long particles around. This will provide less opportunity for sorting.

What about feeding dry hay outside of the TMR? Dry hay can be fed successfully outside the TMR but only under excellent management conditions. The keys are to feed high quality hay to encourage consumption and to provide adequate bunk space for equal opportunity of all cows to consume this hay. This hay intake needs to be carefully managed in order to insure success. Record keeping is vital!

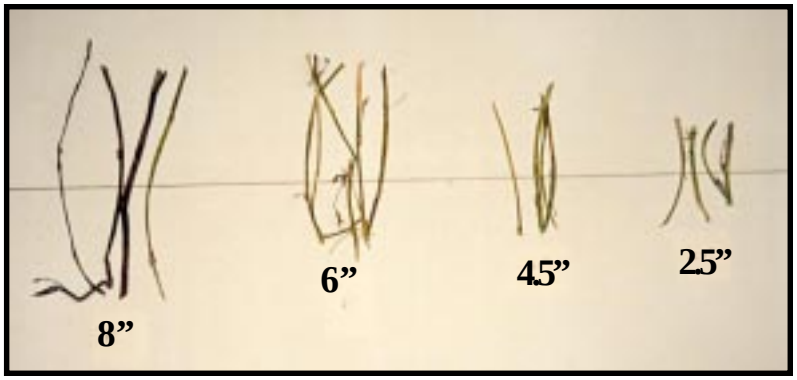
Bunk Management Recommendation #3:

Aim For A Ration Dry Matter of 54-56%: Moisture level of the TMR is a factor in TMR sorting. The addition of water, liquid molasses or byproduct feeds such as wet brewers grains, wet gluten feed, etc. can help add moisture and bind feed ingredients. We feel that a TMR dry matter of 54-56% is too dry and recommend a dry matter range of 46-52% in order to minimize sorting. Caution must be taken to prevent adding moisture by harvesting forages too wet, thus creating a poor fermentation and bunk stability. This will only create another set of problems.

RE-DEFINING TMR PARTICLE SIZE DISTRIBUTION

The use of the Penn State particle size separation box in evaluating TMR particle size distribution is a valuable tool in formulating high-energy rations and troubleshooting effective fiber challenges. As mentioned before, longer particle feeds that are added to the TMR may promote sorting. Our goal is to provide adequate particle length as well as consistent particle length in order to minimize sorting. Therefore, in addition to evaluating the particle size distribution of the three boxes, it is important to evaluate the size variation of the top screen particles. As shown in figure 4, all of these feed particle sizes ranging from 2.5" to 8" can be found in the top screen.

Figure 4. Particle Length Variation in Top Screen



It is important to note that the 6-8” particle length feeds can be more easily sorted than the 2.5-4.5” particle lengths.

It is also important to understand the importance of having adequate particles on the middle screen for optimal performance. A common field scenario is that ensiled forages are harvested with inadequate particle length, so baled hay is added to the TMR. A shaker box analysis reveals adequate particle length on the top screen but much of them are long (>5”), minimal middle screen particles and a high percentage on the bottom screen. Even though the top screen meets requirements, this is easily sorted. With minimal middle screen particles to choose from, the cows consume a high level of bottom screen particles resulting in a potentially acidotic diet. Ideally, we would like to see a TMR particle size distribution of 10-15% in top screen with a particle size range of 2-4”, >50% in the middle screen and <40% in the bottom screen.

SUMMARY

TMR sorting can happen and adjustments in bunk management strategies may be necessary in order to achieve a balanced intake and optimal performance. It is important to understand the ration characteristics that can promote sorting and realize that the cow has the final say in the intake of the different ration feed ingredients and particle sizes. Our goal is to maximize dry matter intake that will allow a balanced intake of protein, energy, fiber, minerals and vitamins that will achieve optimal milk, health, efficiency and cow longevity.

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