Feeding Management and Methods to Reduce Feed Losses and Improve Dairy Cow Performance

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Introduction

Feed costs constitute the greatest percentage of total production costs. Much effort is often placed on formulating optimized rations for cost and production, yet scant attention is given to the implementation of the feeding program. Feedstuff shrink can be huge or minimal, whereas totally mixed rations (**TMR**) can be extremely consistent throughout the bunk or extremely variable. We will discuss shrink and ways to reduce it, and protocols that can be implemented to assist in making a consistent TMR.

Shrink the Shrink

Feedstuff shrink has different definitions. In this discussion, shrink is defined as the amount of feedstuff dry matter that was purchased but not consumed by the cow. Shrink can also occur when loads are being prepared and an ingredient is added beyond the ability of the animal to make use of the excess nutrients.

Shrink represents money down the drain, and it can really add up. For a 1,000 cow dairy averaging 52 pounds of dry matter intake (**DMI**) at $0.13 per pound of dry matter (**DM**), each percentage point of TMR shrink is worth about $25,000. Sometimes simple, relatively inexpensive changes made in the forage and feeding systems result in substantial cost savings.

Greene (2014) discussed various approaches dairies can take to reduce feedstuff losses. Silage losses need to be considered from harvest to the TMR mixer. Ruppel (1995) found in bunker silos filled with haylage that DM loss decreased by about one percentage point for every additional pound of dry matter density achieved in the silo. High losses frequently occur in drive-over piles where the sides are steep and inadequately or not packed at all. Plastic with reduced oxygen permeability, or two layers of quality plastic, will also reduce top spoilage. An important key to minimizing spoilage beneath the plastic is to make sure that air does not infiltrate and traverse beneath the plastic cover. This occurs when the edges of the plastic are not properly weighted down, or when the plastic becomes damaged, and there isn't sufficient weight placed on top of the plastic to keep it tightly adhered to the silage. Gravel-filled silage tube bags help to hold plastic tightly to the silage surface and they will not blow back in the wind.

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Additional losses occur on many dairies at feed-out. Defacers or silage rakes help to keep the silage face straight without disrupting deeper silage layers. Ideally silage would either be loaded directly into the TMR mixer very close to the silage face, or moved to a commodity bay or building for load preparation. Depending on the travel distance and the surface smoothness, considerable waste can occur when loading the mixer.

Dry matter losses were carefully measured for silages and a variety of ingredients in different storage structures (Table 1, adapted from Greene, 2014). On-farm scales and feed management software are necessary to properly measure shrink. Dry matter was measured on silage throughout the filling process, sometimes as frequently as every third load of silage delivered to the bunker. The same equipment was used to measure silage dry matter at feed-out. Amazingly, corn silage losses of only 4.8%, and haylage losses of only 5.6%, were measured on two dairies (Table 1). These dairies weren't doing anything "special", other than doing everything right.

Table 1. Measured shrink values on dairy herds

Ingredient	Herds	Range, %	Weighted mean, %
Corn silage (pile, pit)	15	4.8 – 16.0	9.1
Corn silage (bag)	8	6.5 – 14.0	9.9
Haylage (pile, pit)	12	5.6 – 16.0	10.2
Haylage (bag)	11	8.5 – 17.0	10.7
Feed center (3 sided, open front)	16	2.5 – 11.0	6.7
Feed center (under roof, enclosed)	5	2.0 – 7.0	4.0
Bulky Ingredients (cottonseed hulls, whole cottonseed)	14	3.5 – 14.0	11.3
Upright/overhead storage	7	2.0 – 7.0	4.0
Wet byproducts	13	12.0 – 40.0	23.0
Bagged ingredients	16	2.0 – 19.0	8.1

Large losses in grains can occur from sloppy handling of the ingredients during loading, and from the wind. Shrink is increased every time an ingredient is added to the mixer. It is more efficient if smaller inclusion ingredients are included in a premix. The feeder will only have one ingredient, the premix, to add to the mixer when mixing the TMR. Adding wet ingredients (molasses or whey, for example) to the premix can also help to reduce losses from wind, but be careful that the mix density does not become high enough to impede proper mixing of the premix.

Upright bins reduce shrink by minimizing losses to wind, and eliminating losses that occur when moving with the loader bucket. Shrink is also reduced by the ability to accurately add the ingredient to the mixer. Downspouts, ideally extending below the top of the mixer, further reduce losses from wind.

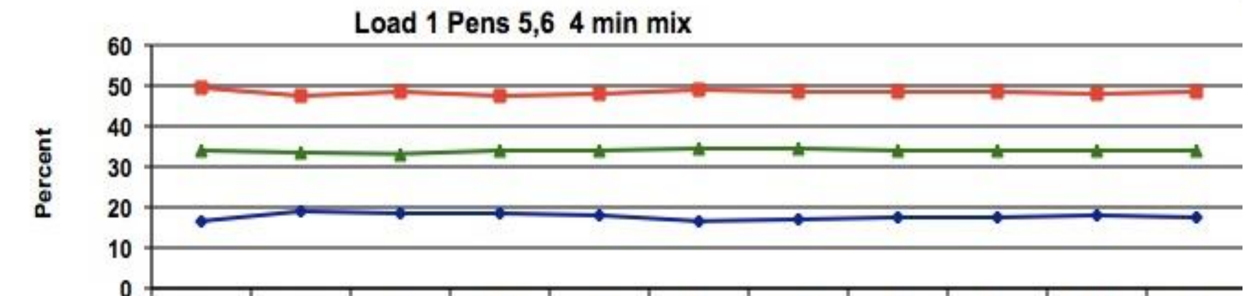
More dairy producers are constructing enclosed feed centers to reduce shrink from wind, wildlife, and weather damage. Feed centers also help to enhance TMR uniformity and accuracy by having the forages that will be fed that day out of the weather, and being able to load out of the wind.

TMR Audits

A TMR Audit consists of an intensive evaluation of the feeding system (Oelberg and Stone, 2014). One of its primary objectives is to reduce the amount of variation between the formulated and consumed ration. The Diamond V Technical Services team has conducted several thousand TMR Audits on dairies across the United States. Anecdotally, we have observed an improvement in performance as feeding routines were changed and TMRs became more consistent.

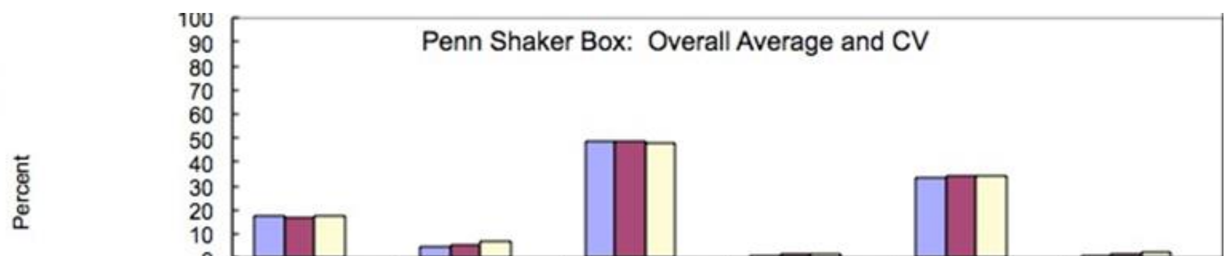
Forage within a bunker silo varies in DM and nutrients primarily across the vertical, but also somewhat across the horizontal, aspect of the silo. To minimize this variation, forages should first be defaced (starting from the bottom and working up), and then pushed into a central pile with the loader bucket and further mixed with the loader bucket. The feeder should be careful to include any forage at the bottom of the silo that was not removed with the defacer. This basic procedure, which should be taught to all feeders, helps to make the TMR consistent throughout all loads of feed.

One of the objective measurements in a TMR audit is an evaluation of the TMR particle size distribution along the length of the feedbunk. Ten TMR samples, approximately 1.4 L in volume and moderately packed, are collected along the feedbunk in a proportional distance to the unloaded TMR. TMR samples are then run through the Penn State Particle Separator (two sieve and pan) according to the recommendations of Lammers et al. (1996) and Kononoff et al. (2003). The particle size distributions are graphed and the coefficient of variation (**CV**) for each sieve and the pan determined. Our goals are to have CVs less than approximately 2.5% for the middle sieve and pan. The top sieve often has much less material on it, and hence it can be more difficult to have a small CV for the material retained on this sieve. However, the top sieve CV can be kept to less than 10% even with relatively small amounts of TMR retained on it. TMRs can be highly consistent (Figures 1a and 1b) or variable (Figures 2a and 2b).



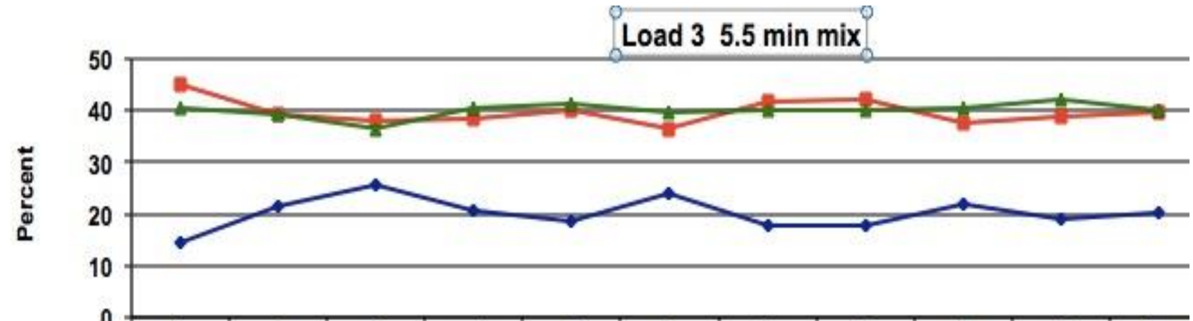
	1	2	3	4	5	6	7	8	9	10	Ave
Top	16.6	19.1	18.6	18.4	17.8	16.6	17.0	17.6	17.6	18.0	17.7
Middle	49.4	47.5	48.3	47.7	48.2	48.8	48.7	48.6	48.4	48.2	48.4
Bottom	34.0	33.4	33.2	34.0	33.9	34.6	34.3	33.8	33.9	33.8	33.9

Figure 1a. An example of an extremely consistent TMR that was prepared by a twin-screw vertical mixer wagon. The figure contains the percentages of the TMR retained on different sieves of a Penn State particle separator from ten sequential samples taken from a load of TMR.



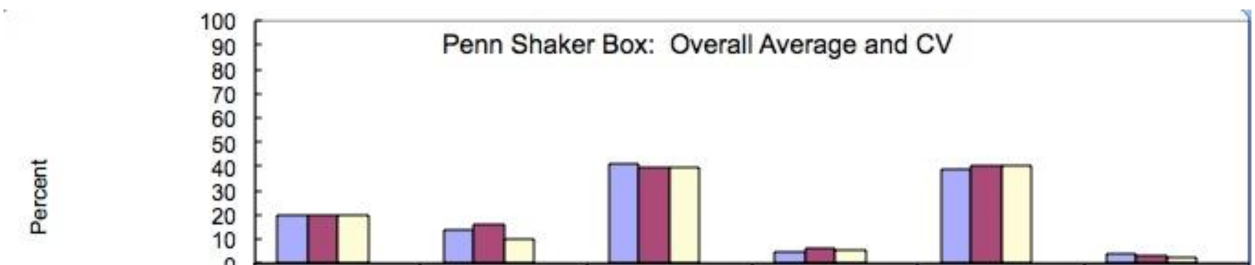
	Top		Middle		Bottom	
	Average, %	CV,%	Average, %	CV,%	Average, %	CV,%
Pens 5,6, 4 min mix	17.7	4.6	48.4	1.1	33.9	1.2
Pen 1,2,3 5 min mix	16.6	5.9	49.0	1.7	34.4	1.6
Fresh	18.0	7.0	47.6	2.0	34.4	2.4

Figure 1b. The average percent of TMR retained and CV from three loads of TMR (including the results from Figure 1a) where ten samples of TMR were collected sequentially along the feedbunk and then shaken through the Penn State particle separator. All loads and screens were within our goal ranges for CV of less than less than 2.5% for the middle sieve and pan, and ideally less than 10% for the top sieve.



	1	2	3	4	5	6	7	8	9	10	Ave
Top	14.3	21.3	25.6	20.8	18.6	23.9	17.9	17.6	21.7	19.2	20.1
Middle	45.2	39.4	37.8	38.6	40.2	36.5	41.9	42.2	37.7	38.9	39.9
Bottom	40.5	39.3	36.5	40.6	41.2	39.5	40.1	40.2	40.5	42.0	40.0

Figure 2a. An example of an inconsistent TMR that was prepared by the same type of twin-screw vertical mixer wagon used to prepare the TMR in Figure 1a. The figure contains the percentages of the TMR retained on different sieves of the Penn State particle separator from ten sequential samples taken from a load of TMR.



	Top		Middle		Bottom	
	Average, %	CV,%	Average, %	CV,%	Average, %	CV,%
Load 2 3 min mix	20.0	14.2	41.1	4.9	38.9	4.2
Load 3, 5.5 min mix	20.1	16.4	39.9	6.5	40.0	3.6
Load 4, 6.5 min mix	20.2	9.8	39.5	5.3	40.3	2.4

Figure 2b. The average percent of TMR retained and CV from three loads of TMR (including the results from Figure 2a) where ten samples of TMR were collected sequentially along the feedbunk and then shaken through the Penn State particle separator. None of the loads met the goals of CV of less than 2.5% for the middle sieve and pan, and ideally less than 10% for the top sieve. To address these problems and improve consistency, a defacer was purchased, mix times were made more uniform via a timer, and the order of adding ingredients was changed.

The primary factors contributing to TMR variability within and between loads include the following:

1. Equipment wear (augers, kicker plates, knives, etc.)
2. Mix time after the last ingredient
3. Load size
4. Levelness of mixer during mixing
5. Loading position on the mixer box
6. Hay/straw quality and processing
7. Loading sequence
8. Liquid distribution
9. Vertical mixer auger speeds
10. Hay restrictor plate setting in vertical mixers

Equipment wear. Feed mixing equipment is not routinely evaluated like most milking equipment. Worn equipment doesn't work properly. The kicker plate is mounted on the lateral aspect of the leading edge of the auger. Most, but not all, vertical mixers utilize a kicker plate to remove feed from along the bottom wall of the mixer. This allows feed from the upper aspect of the mixer to move down the wall. The mixing process occurs as feed is "falling" along the wall, and then "rising" more in the center regions of the mixer because of the auger movement. A worn kicker plate does not remove sufficient feed from the wall of the mixer, resulting in improper feed flow and inadequate mixing. Worn augers won't mix properly, while dull or missing knives won't adequately process long forage. Dairies should have regular maintenance programs, measuring the clearance between the kicker plate and the mixer wall, and evaluating augers, knives, and other parts on the mixer. Although the frequency will vary with ingredients, this should be done approximately every 500 loads.

Mix time after the last ingredient. Although it seems to be getting a lot better, many feeders still don't use a timer to monitor mix time after the last ingredient has been added to a load. The best procedure is to utilize the timer function available on most feed management software programs, but external timers (phones, clocks on radios, etc.) can also be used. Most mixers need about 4 ± 1 minutes to properly mix when run at nearly full power (1,700 to 2,000 RPM engine speed). This can be assessed with the TMR sampling procedure discussed above.

Load size. Feed particles mix best when they are falling, or at least dropping, together at the same time. Additionally, shrink increases if load sizes are too large and feed is spilling out of the mixer. Reel auger mixers are notoriously over-loaded. One simple technique we have learned is to simply observe the mixing action of the mixer when a full load of feed is being mixed. Feed should be actively moving in all visible areas of the load of feed.

Levelness of the mixer during mixing. An unlevel mixer can lead to feedstuffs migrating to a region of the mixer, and to feed spilling out of the mixer box. Loads should be level at least during mixing, and preferably at all times. In addition to parking on level ground, sometimes the hitch can be moved up or down to level out the mixer wagon.

Loading position on the mixer box. Why make it any harder on the mixer than necessary? Targeting the loader bucket for the center of the feed mixer assists in uniform feed distribution throughout the mixer more quickly.

Hay/straw quality and processing. Alfalfa hay straw should be processed to less than 3 to 4” and straw to less than 2” to minimize sorting. Another thumb rule is to have the particle size distribution of straw be approximately 1/3, 1/3, 1/3 on the Penn State Particle Separator (Dann, 2012, Personal communication). Most dairies process hay and straw prior to loading to ensure proper particle size and reduce equipment wear on the mixer. If processing is done prior to mixing, ideally the discharge chute of the forage grinder can be set to blow directly into a totally enclosed space to reduce shrink during chopping. Properly maintained knives in a vertical mixer can adequately process forage, and they typically result in less shrink. However, a trade-off that occurs is increased mixer wear. Additionally, the straw or hay bales should be broken apart and premixed with the loader bucket to reduce forage variability.

Loading sequence. Equipment maintenance, load size, and mix time all trump loading sequence, but it too can affect mix uniformity. Loading sequence will depend on mixer type, ingredient type (density, particle size, moisture level and flowability), inclusion level, and convenience of the feeder relative to ingredient location. Generally, lower density and large particle feeds (straw, hay) are loaded first, followed by dry grains, wet by-products, haylage, corn silage, and liquids. Haylage can go in earlier if clumps are present and a longer mix time is desired to try to break down clumps. However, the best way to break down haylage clumps is with a defacer. Sometimes the best loading sequence for a given mixer and set of feedstuffs can only be determined by experimentation.

Liquid distribution. Liquids should be added so that they are dispersed over the central half to two-thirds of the mixer.

Vertical mixer auger speeds. Remember that feed particles mix best when they are falling or actively moving. If the vertical augers are moving too slowly, the feed movement may not be sufficient for feed particles to mix properly. Different companies have designed their equipment to mix at different speeds, but in general TMR consistency will be enhanced when auger speed is increased.

Hay restrictor plate settings in vertical mixers. Restrictor plates force the TMR closer to the auger, enhancing the cutting action of knives. However, they also decrease the mixing action within the mixer. If the mixer is not being used to process forage, then the restrictor plates can be set all the way out on most mixer wagons.

Conclusion

Shrink can cut into a dairy’s profitability or deepen its losses, while an inconsistent TMR can impair animal performance. The good news is that often, both can be substantially improved by fine-tuning protocols on the dairy along with targeted equipment and facility repairs and investments. Review these areas on your dairy, or your clients' dairies, and see where improvements can be made.

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SESSION NOTES