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Efficient feed center design

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Most of the production cost on a dairy is associated with feeding the lactating cows. However, dairies often do not calculate the costs associated with shrink or "the percentage of feed on a farm that is not accounted for by the rations of the animals for which it is intended."

Brouk (2010) determined the cost of a corn silage-based ration equaled $5.49 per head per day assuming zero shrinkage. Daily feed cost increased to $6.05 per head when typical shrink values were applied to each feed ingredient in the diet. If shrink losses were reduced by 50 percent for each ingredient, daily feed costs were reduced to $5.75 per head. The difference in daily feed cost of $0.30 per head due to reduced shrink results in an annual savings of $100 per cow.

Causes of shrink may include wind, wildlife (birds and rodents), moisture or spoilage, delivery weight errors, discarded feed, feed dispersed by tires and tracking, and mixing errors On-site dairy discussions tend toward considering shrinkage as a part of normal feed cost and opportunities for improvement are considered limited. However, a willingness to understand true costs related to shrinkage and addressing these problems can lead to significant economic benefits.

Impact of facilities on shrinkage

Shrink values for different ingredients vary depending upon the design of the area in which they are stored. Designing a feed center to minimize the impact of solar radiation, moisture and wind may have economic returns due to reduced shrinkage.

The minimum expected loss is 10 percent when ingredients are stored in uncovered open piles, 8 percent when stored in 3-sided bay commodity buildings and 2 to 5 percent when kept in storage bins. Common areas where shrinkage losses occur when storing ingredients in commodity buildings include the following:

- Unloading on concrete slab – wind movement of ingredients or failure to move 100 percent of an ingredient into a bay.
- Ration preparation – accuracy of measuring individual ingredients with a bucket loader is limited to about 1 to 2 cubic feet, resulting in over or under feeding individual ingredients.
- Weather – buildings are often oriented based upon prevailing wind, leaving feed exposed to blowing precipitation and resulting in spoilage due to rain or snow.
- Number of bays – failure to completely empty bays often results in some degree of spoilage of ingredients along the back wall due to inability to use it in a timely manner.
- Management – more emphasis on time or getting cows fed, versus accuracy of feed ration.
- Feed center layout – efficiency in procurement of ingredients.

Feed is purchased at a given cost per unit weight or volume, but actual feed cost may be significantly higher depending upon shrinkage losses that occur. For example, a dairy might pay $30 per ton of silage, but if there are 20 percent losses due to shrinkage then the actual cost per ton of silage used in the ration is $37.50. If silage losses can be reduced to 12 percent it would save an estimated $3.43 per ton of silage fed.

Realistically, there will always be some shrinkage and loss. Each dairy must have a realistic target, and for most ingredients other than forages 2 to 4 percent is a reasonable target. Fermented forages or grains will have some loss associated with the fermentation process. If this fermentation occurs at the dairy the goal should be less than 10 percent for fermented forages and below 5 percent for fermented grains.

Impact of moisture on shrinkage

Feed ingredients are often purchased on a wet basis, but are formulated into rations on a dry weight basis. The impact of moisture must be considered when evaluating shrink. An ingredient such as hay purchased and delivered at 15 percent initial moisture content, but dries while in storage to 14 percent, has 1.16 percent less moisture. If moisture loss is not considered, then for every 1 percent reduction in moisture there is a 1.16 to 2.78 percent increase in dry matter depending on the initial moisture content. Similarly, if moisture increases 1 percent due to rain or snow there is 1.16 to 2.78 percent decrease in dry matter if the diet formulation is not adjusted.

Rain or snow entering the open commodity storage sheds presents another moisture concern. For example, 15 gallons of water per linear foot will enter a bay of a commodity shed with a 24-foot high sidewall. If a curtain is dropped to reduce the opening to 8 feet (skid steer height), there is a 67 percent reduction in water entering the bay. A 50 percent reduction occurs if a curtain is dropped leaving a 12-foot (pay loader height) opening.

Lowering a curtain or flexible door at night or upon completion of feeding may prevent significant ingredient losses due to rainfall and subsequent spoilage. Frequency of rainfall events would determine curtain management and frequency of lowering. Curtains also minimize the impacts of wind and potential movement of ingredients between bays without solid dividers. Buildings storing commodities delivered in live-bottom trailers may be able to reduce sidewall height to a 14-foot opening using permanent materials.

Impact of scales on shrinkage

Producers adding small quantities of ingredients may reduce shrink by using a smaller stationery

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mixer with more accurate scales to pre-weigh these ingredients before moving them into a larger mixer. For example, if 1,230 pounds of almond hulls are added to a 10-ton mix, a 1 percent scale accuracy allows for measurement of this amount to the nearest 200 pounds, meaning that the potential exists for a ±16 percent weighing error. On most dairies nutritionists formulate rations to the nearest pound, but the weight readout may be to the nearest 10 pounds and the fill mechanism into the mixer is a pay loader which may have an accuracy of only 50 to 100 pounds.

There are two basic types of scale errors.The first is inconsistency of the scale. This type of error occurs when a scale reading is incorrect by a consistent percentage across the range of the scale. Thus, the scale may add an extra 25 percent to the weight of each individual ingredient.

When this error occurs the ration is still formulated correctly, but each group of cows may be overfed by 25 percent. The weight of the ration may be adjusted down due to excessive weighbacks, however the nutritionist never knows the exact quantity of feed being consumed by a pen of cows even if the percentage of individual ingredients may be at the right proportion. This can be problematic in part because expensive, low-inclusion ingredients such as feed additives may be formulated at higher concentrations in the diet in an attempt to achieve a desired intake on a per cow per day basis. Underestimation of feed intake, therefore, leads to excessive intake of these relatively expensive ingredients.

The other error is consistent weight addition or subtraction; the scale adds a fixed amount of weight to every ingredient added to the ration. For example, 25 pounds is added to one ingredient formulated at a 500-pound inclusion rate and 25 pounds is added to a second ingredient formulated at a 4,000-pound inclusion rate. In this case the nutritionist may not realize the ingredients at smaller inclusion rates are being over- or under-fed in the diet. This type of error may parallel health issues related to ingredients added at lower rates, since the percentage of over- or under-feeding is much greater as compared to an ingredient such as corn silage.

Larger dairies may find it economically beneficial to install a stationery mixer where operational conditions are more controllable, and then use a feed delivery wagon to move feed to the bunks. The other advantage of a stationery mixer is automation and extra time available. Automation reduces the number of employees actually adding ingredients to the mixer. This increases accuracy and reduces variability due to human error when adding ingredients to the mixer.

Wind and shrinkage

Windbreaks can be used to reduce shrinkage around 3-sided commodity buildings. A windbreak protects an area 10 times its height, so if the windbreak is 10 feet high the protected area is 100 feet. The snow dump area is 4 times windbreak height. The distance between the feed center and the windbreak should be at least 4 times the windbreak height to prevent snow from piling in the feed center or covering traffic roads.

Normally it is recommended that windbreaks have 20 percent openings. However, this is not as critical around feed centers. A permanent windbreak is recommended since shrinkage losses due to wind occur year-round. Some producers opt to store hay or bedding around the perimeter of the feed center or pens, but this limits wind protection to only those periods when the hay or bedding is being stored.

Dairies located in areas with colder climates or

Figure 1

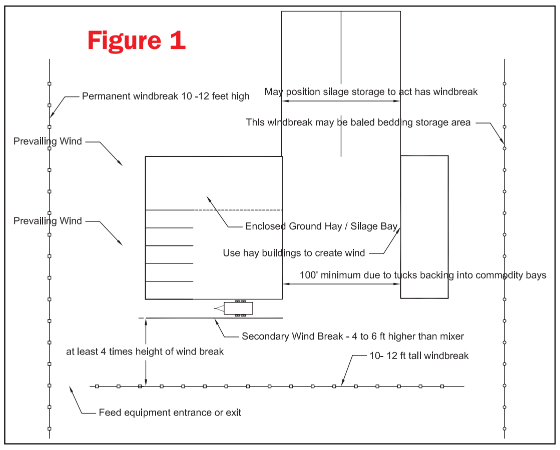


Figure 2

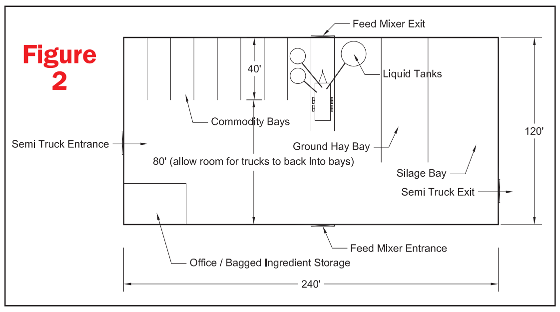
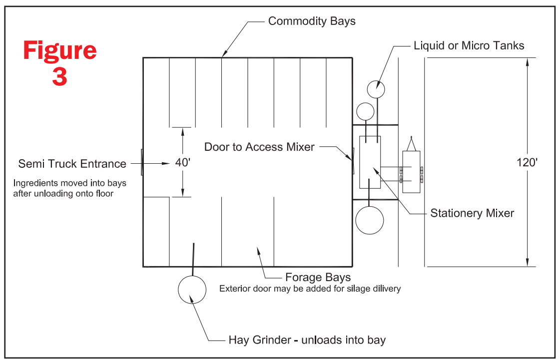


Figure 3



excessive rainfall may benefit from placing the entire feed center under a roof to eliminate moisture and wind problems. In this arrangement silage is delivered from the silage storage area daily and placed in a bay inside the building. Several bays are also available for ground hay. Hay storage remains in separate buildings until it is ground or immediately prior to usage.

Working with ingredient suppliers and trucking firms is critical prior to construction, since adequate room must be available inside the building to maneuver semi-trucks. More space is required if trucks are required to back into bays prior to unloading versus unloading on a slab (with the ingredients pushed into a bay).

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Low density feed ingredients should be delivered in self-unloading trucks (walking floors) when ingredients are stored in open front commodity buildings. Many dairies have reported significant shrink when low density products are unloaded on an apron prior to transferring into a bay on windy days. If ingredients are unloaded on an apron, shrink is minimized by immediately moving them into a bay.

Wind speeds of 6 miles per hour may cause soil movement in highly erodible fields. Sand with a dry weight density of 4 to 10 times that of most feed ingredients begins movement at 12 mph. Reducing wind speeds around the feed center is critical to minimize shrink, as well as preventing deposits of soil from adjacent areas into the commodity bays.

Windbreaks also help minimize soil and foreign matter from accumulating in the feed center area. Feed centers surrounded by large crop acreages often serve as a windbreak, causing materials to settle out in commodity bays during wind storms. This foreign matter is included as part of individual ingredient weights, resulting in feed formulation errors. Average annual soil losses due to wind have been reported at 2.5 tons per acre of land (Lyles, 1975). Wind erosion is higher from fields with less surface residue such as corn silage fields. An exterior windbreak causes this material to settle prior to entering the feed center area.

Design to minimize shrinkage

Figure 1 is an illustration of a windbreak around a feed center. The windbreak should be located at least 4 times the height of the windbreak away from the feed center. This space will serve as a snow dump area. If snow is not an issue then the windbreak may be located closer to the feed center. L-shaped commodity sheds provide protection from the wind from multiple directions.

Feed center protection is increased if the building is oriented such that the prevailing wind is perpendicular to the intersection of the two building sides (corner of "L") than along one side. A single row of commodity bays may be modified along one side to include a second building to provide additional wind protection. Many dairies also need a place to store additional commodities, ground hay, or daily silage needs prior to feeding.

Figure 2 is an illustration of a totally enclosed commodity building. The advantage of this building type is that weather-related shrinkage losses are minimized. Overall building width is typically 60 to 80 feet wider than a 3-sided commodity building, which is necessary to provide adequate room inside the building for semi-trucks delivering ingredients to maneuver. The authors recommend consulting with trucking firms to make sure there is adequate room. Significant reductions in open space may increase feed loading time, since feed loading equipment may not have enough space to maneuver rapidly.

Figure 3 illustrates a feed center with a stationery mixer. There is room around the mixer to use micro ingredient tanks as well as liquid tanks. Stationery mixers enable more hopper-bottom tanks with automated handling equipment to be utilized for low inclusion rate ingredients and liquids. Commodity bays are in close proximity of the stationery mixer, allowing adequate time to secure individual ingredients. Another advantage is minimum losses due to weather shrinkage.

This article is based on proceedings from the Western Dairy Management Conference held in Reno, Nevada, March 9-11, 2011. References are available in the original proceedings that will be available online at http://www.wdmc.org/