Beef feed storage from an engineering perspective

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There is a large potential and actual feed loss in the beef industry. There are engineering solutions to some of the causes of feed loss but those solutions can have capital investment and annual cost requirements. To keep a beef operation economically viable, costs incurred must be recovered by savings. Table 1 can be used to estimate the value lost per ton of hay when an estimated loss of dry matter occurs. One way to use this table is to assume a certain practice can save 10 % dry matter loss when hay is valued at $150/ton. Under this condition, $15/ton of hay can be saved. Whatever system saves $15/ton, it must not cost more than $15/ton to implement for it to be a viable alternative.

Table 1. Value of hay lost as a function of hay price and dry matter loss*

	Hay Price ($/Ton hay)					
DM Loss (%)	**50**	**100**	**150**	**200**	**250**	**300**
		---------- *Value Lost ($/Ton hay)* ----------				
5	2.5	5.0	7.5	10.0	12.5	15.0
10	5.0	10.0	15.0	20.0	25.0	30.0
15	7.5	15.0	22.5	30.0	37.5	45.0
20	10.0	20.0	30.0	40.0	50.0	60.0
25	12.5	25.0	37.5	50.0	62.5	75.0
30	15.0	30.0	45.0	60.0	75.0	90.0
35	17.5	35.0	52.5	70.0	87.5	105.0
40	20.0	40.0	60.0	80.0	100.0	120.0
45	22.5	45.0	67.5	90.0	112.5	135.0
50	25.0	50.0	75.0	100.0	125.0	150.0

*Hay assumed to be 16% moisture

Where do the dry matter losses occur in hay making?

Hay dry matter losses occur in the harvesting, storage and feeding processes. Table 2 can be used to estimate losses occurring in the harvest process. Values can vary quite a bit based on weather and technology and management used. Dry matter losses occurring in this phase can influence the losses that occur in the storage phase. Hay stored outside and exposed to oxygen, precipitation, high humidity, shade, warm temperature and soil moisture decomposes at a faster rate than when protected from moisture sources. The longer hay is stored under high rate decomposing conditions the higher will be the overall loss of dry matter. Table 3 can be used to estimate losses that occur in hay stored under a variety of conditions in a moist climate. The method by which hay is presented to beef cows and their feeding behavior influences the degree of feed waste. Slant bars on the feeding fence can limit how much hay is pulled through the fence and onto the ground. Once feed is on the ground it is susceptible to trampling and will not be consumed. Feeder design has a large effect on how much feed is wasted by the animals. If the feeder is designed so feed pulled from the bale is dropped within the feeder, loss will be less than if dropped on the ground and is trampled. Table 4 is based on research and observation of animal wastage.

Table 2. Expected dry matter losses for hay harvested as dry hay, wrapped silage bales and chopped for silage. Values in parentheses are typical.*

Process	Dry Bales	Wrapped Silage Bale	Chopped for Silage
Mow and Condition	1-4 (2)	1-4 (2)	1-4 (2)
Respiration	1-7 (5)	1-7 (5)	1-7 (4)
Tedding	2-8 (3)	2-8 (3)	2-8 (3)
Swath Inversion	1-3 (1)	1-3 (1)	1-3 (1)
Rake	3-20 (7)	1-20 (5)	1-20 (5)
Rain	0-50 (5)	0-50 (3)	0-50 (3)
Bale	3-9 (6)	2-8 (5)	N/A
Chop	N/A	N/A	1-8 (3)
Plastic wrap	0-3 (1)	0-1 (0.5)	N/A

* 1% DM Loss is typical for mowing/conditioning and tedding grass hay

Table 3. Estimates of dry matter loss for hay stored under a variety of conditions in a moist (> 40 inches precipitation/year) climate. Values in parenthesis are typical.

Storage Type	Dry Hay Bales	Silage Bales
	---------- dry matter loss (%) ----------	
On Floor/Stone Base w Roof	3-5 (3)	N/A
On Ground w Plastic Wrap	4-10 (4)	1
On Ground w Plastic Sleeve	4-10 (5)	N/A
On Ground w Roof	2-10 (4)	N/A
On Ground, Net Wrap, Breathable Wrap	2-7 (3)	N/A
On Pallets, Tarp	2-17 (3)	N/A
On Stone Base, Tarp	2-17 (4)	N/A
On Pallets, Uncovered	3-20 (9)	N/A
On Stone Base, Uncovered	3-20 (9)	N/A
On Ground w Tarp	4-30 (9)	N/A
On Pallet, Net Wrap, Uncovered	5-9 (6)	N/A
On Stone Base, Net Wrap, Uncovered	5-9 (7)	N/A
On Ground, Net Wrap, Uncovered	2-20 (8)	N/A
On Ground, Plastic Twine, Uncovered	5-20 (10)	N/A
On Ground, Uncovered, Sisal Twine	5-30 (15)	N/A

Table 4. Dry matter loss based on feeding method for beef cows

Feeding Method	Dry Matter Loss (%)
Whole round bale on the ground	50 +/-
Strip of hay on the ground	24
Strip of hay on the ground-electric fence limits access	18
Cradle feeder with inclined bars	15
Ring feeder with round bale	6, 13
Trailer feeder with vertical bars	11
Cone feeder with round bale	4

Consider the example of a producer who teds his hay, harvests dry hay in plastic twine wrapped large round bales without being rained upon during harvest, stores the bales on the ground outside and feeds the bales to beef cows in a strip on the ground. The loss of hay might be in the order of 57% (23% + 10% + 24%). If that same producer placed the plastic twine tied bales on a stone base with a tarp and fed the bales in a cone feeder, the expected losses might be in the order of 31% (23% + 4% + 4%). The savings for changing the practices is 26% (57% – 31%). The savings for hay at $150/T is $39/T (150$/T * 0.26). If the increased cost of the stone base, tarp and the cone feeder(s) is less than $39/T of hay fed, the change will be profitable.

An economic analysis of feed storage alternatives considering initial and annual costs can help establish the better system alternatives for your operation. This analysis can be facilitated by spreadsheets available for download. Look at the "Hay Storage Cost Comparison A1-15" spreadsheet on the Iowa State University Ag Decision Maker web site, http://www.extension.iastate.edu/agdm/decisionaidsall.html

A more complicated spreadsheet is available as "Comparing Round Bale Storage Costs" available on the UW Extension Harvest and Storage page of the Team Forage web site at http://www.uwex.edu/ces/crops/uwforage/storage.htm

Can silage be used for a beef herd?

One way to use hay as silage is as wrapped silage bales. The hay is baled at 40-50% moisture and wrapped to exclude oxygen as individual bales or as tube wrapped lines of bales. Compared to dry hay, losses can be reduced by shortening the time hay is exposed to respiration, reduced loss in raking and baling and a reduced chance of being rained upon before harvest and elimination of exposure to oxygen during storage. Losses in feeding will be similar to those listed in Table 4 unless the feed is not consumed within five days, whereupon feed instability may develop.

Some beef producers are considering if chopped forage can be stored in bunker, pile or bag silos for their operation. If the forage is harvested at the correct stage of maturity and moisture, packed into the storage tightly and covered properly, good quality silage can be made. One of the big concerns is if the feedout rate can be large enough for the size of herd and the storage selected. If not, high levels of feedout loss due to aerobic deterioration can be experienced. Table 5 was developed to help answer the question of what minimum size herd is needed to have adequate feedout rate from three different types of silage storage.

Table 5. Design criteria for silage storages.

Criteria	Bunker silo	Pile silo	Silo bag
Face Removal Rate (in/day)	12	12	18
Height (ft)	8	10 or 5	N/A
Width/Diameter (ft)	20	N/A	8
Side Slope (rise/run)	N/A	1/3	N/A
Dry Matter Density (lbs DM/ft^3)	15	15	13

In the case of corn silage, the animals in the feedlot were assumed to be equal in number for growing (700 lbs/animal) and finishing (1000 lbs/animal). Growing animals receive 12.25 lbs DM corn silage/animal/day and the feeders receive 5 lbs DM corn silage/animal/day. The values in Table 6 show the minimum feedlot herd size to justify the type of silage storage based on assumptions used in the analysis.

Table 6. Minimum number of animals in a feedlot to assure adequate feed out rate from a corn silage storage.

Silo Face Removal Rate (in/day)	Storage Type			
	Bunker Silo (8′ x 20′)	Pile Silo (10 ft high)	Pile Silo (5 ft high)	Silo Bag
	Minimum number of animals in feedlot			
12	278	520	130	N/A
6	139	260	65	N/A
18	N/A	N/A	N/A	114

The smallest herd in a feedlot is 65 animals when a 5 ft tall pile is built and fed out at 6 inches per day. The next smallest herd (114 animals) uses an 8 ft diameter silo bag fed at 18 inches per day. Obviously, larger storages require larger herd sizes to be fed out at reasonable rates.

A similar question is asked about using hay silage for the beef cow herd. Using the same assumptions of Table 5 and a hay silage consumption rate of 26 lbs hay silage DM/cow/day, the minimum cow herd size was developed in Table 7.

The smallest herd is 22 cows when a 5 ft tall pile is built and fed out at 6 inches per day. The next smallest herd (38 cows) uses an 8 ft diameter silo bag fed at 18 inches per day. Obviously, larger storages require larger herd sizes to be fed out at reasonable rates.

Table 7. Minimum number of beef cows to assure adequate feed out rate from a hay silage storage.

Silo Face Removal Rate (in/day)	Storage type			
	Bunker Silo (8′ x 20′)	Pile Silo (10 ft high)	Pile Silo (5 ft high)	Silo Bag (8′ dia.)
	Minimum number of cows in herd			
12	93	174	44	N/A
6	46	87	22	N/A
18	N/A	N/A	N/A	38