Western Dairy News
for the West, about the West, from the West
January 2006
Volume 6, No. 1

Bunkers, piles, or bags: Which is most economical?

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Because the forage component of the dairy cow ration is critical, information pertaining to silage that can be used by dairy managers to make sound decisions is plentiful. However, information specifically looking at the economics of alternative storage systems is somewhat sparse. Many factors influence which silage storage system is best for a particular dairy ; thus, each manager must evaluate their unique situation.

The "most economical manner" of silage storage refers to the cost of the silage (producing, harvesting, storing, and feeding) and the impact that silage has on milk production (income). The lowest cost per ton should only be the goal if a milk-production-per-ton-adjustment has been made. Evaluation of costs per ton of feed will vary depending on the assumptions made prior to making the calculations. The objective of this article is to develop a framework for comparing the economics of three different types of silage storage structures, bunker silos, drive-over or wall-less piles, and silage bags. A companion Excel spreadsheet (SilageStorage$.xls) is available at http://www.agmanager.info/livestock/budgets/production/default.asp#Dairy. This spreadsheet can be used as an aid for making decisions regarding these systems.

When evaluating the economics of silage storage alternatives, it is important to recognize several factors. (1) Silage storage costs will vary between dairies due to forage type, herd size, facilities, and management ability. (2) Some economic inputs required for evaluating storage alternatives such as labor availability for packing or covering silage piles, feed out considerations, delivery rate of silage to the storage area, etc. may be difficult to quantify but impact the ultimate decisions. A realistic estimation of these associated costs should be made. (3) Once costs have been objectively estimated, other more subjective factors also may need to be considered in making the final decision. Table 1 lists some of the relative merits of each of the silage storage alternatives.

Table 1: Advantages and disadvantages of silage storage alternatives

alternatives	advantages	disadvantages
Concrete Bunkers	• High capacity • Smaller footprint • Fast unloading rate • Stable forage quality if packed correctly • Relatively low "out of pocket" cost • Utilizes conventional farm equipment	• High initial investment • Packing influences DM losses • Cost effective for small herds • Cost/availability of labor • Safety concerns
Drive-over Piles	• Low initial capital investment • Flexibility of pile quantity • Fast unloading rate • Utilizes conventional farm equipment	• Larger footprint than bunkers • Flooring potentially expensive • Cost/availability of labor • Safety concerns
Plastic Bags	• Low initial capital investment (assuming custom bagging) • Flexible storage system • Small feedout face to manage • Low DM loss if managed properly • Feed can be inventoried easily • Fewer safety hazards	• High annual "out of pocket" expense • Largest footprint • Flooring potentially expensive • Need specialized equipment • Small "feed out face" • Cows may ingest plastic • Plastic bags not reusable

Costs of Silage Storage

Determining the cost of delivering silage to the herd will be complex if all of the economic components such as silage production, storage, silage removal and delivery, are included. Dairies should focus their efforts on estimating the major cost differences and not be overly concerned about assuming minor costs are similar across different alternatives. The important expense categories to consider are discussed below.

Site and structures – The annualized cost, as opposed to investment, of the site and structure is important and includes market-based depreciation, interest, repairs and maintenance. The land area or footprint required for the storage system is also important because the dairy may have space constraints. Although land cost may represent a small percent of the total costs, the cost of developing the land (i.e., land leveling, base material, floor/surface, etc) can be significant and must be included.

Cost of silage delivered to storage – The cost of silage delivered to storage is similar to the purchase price for silage. This value reflects either the costs of production or a market value (i.e., opportunity cost) of home-grown silage.

Packing or bagging costs – The cost of packing or bagging represents the cost associated with getting the silage into storage. If this cost includes the cost of the

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Comparison of Economic Costs – Example Dairy

The production-adjusted cost per ton of silage delivered to cows was estimated for a hypothetical 3,000 cow dairy. The following assumptions were made for the dairy:

Assumptions used in economic analysis:

herd size, cows	3,000
silage in ration, as-fed (AF) lbs/cow/day	45.0
silage moisture content, %	68.0
maximum feeding days per storage structure	122 (implies min. 3 structures)
interest rate, %	10.0
land value, $/acre	$1,000
useful life for structures, years	30.0
annual repair and maint, on structures, %	1.5
cost of silage delivered to storage, $/AF ton	$25.00
cost of plastic, $/sq ft	$0.030
labor cost, $/hour	$10.00
milk price, $/cwt	$13.50

	concrete bunkers	drive-over piles	plastic bags
required number of storage units[a]	3.9	4.0	40.0
size of footprint, acres[a]	2.5	3.5	4.7
cost of floor/base, $/sq ft	$1.80	$0.90	$0.90
estimate of DM loss (storage and feed out), %	20.0	5.0	10.0
investment in structure, $/AF ton capacity[a]	$59.72	$23.96	$24.59
cost of packing or bagging, $/AF ton	$1.10	$1.10	$6.00
hours for covering silage, man-hrs/unit	50.0	50.0	0.0
other annual storage-related costs, $/unit[b]	$500	$500	$100
change from baseline milk production, lbs/day	0.0	0.0	+1.0

a: based on specific assumptions not provided here and calculated in SilageStorage$.xls

b: estimated costs for disposing of plastic covers and bags

Table 2: Economic Comparisons of Alternative Silage Storage Systems

	(silage storage system) bunker silo	drive-over pile	plastic bags
Storage-type-specific inputs			
Tons of silage stored, AF	31,997	32,850	27,683
Plastic required for covering bunkers and piles, sq ft	25,261	37,345	na
Estimate of storage DM loss, %	18.0%	20.0%	8.0%
Estimate of feedout DM loss, %	5.0%	5.0%	3.0%
Total DM loss, %	23.0%	25.0%	11.0%
A. Full cost scenario			
Structure investment per ton of storage capacity, $/ton AF	$59.72	$23.96	$24.59
Annual cost of structure and land, $/ton AF	$7.24	$2.91	$2.99
Total cost of silage into storage, $/ton AF	$33.46	$29.13	$34.14
Total cost of silage into storage, $/ton DM	$104.55	$91.03	$106.68
Total cost of silage out of storage, $/ton AF	$43.45	$38.84	$38.36
Total cost of silage out of storage, $/ton DM	$135.78	$121.37	$119.87
Silage cost adjustments due to quality			
Milk prod. adjusted cost of silage out of storage, $/ton AF	$43.45	$38.84	$33.02
Milk prod. adjusted cost of silage out of storage, $/ton DM	$135.78	$121.37	$103.18
B. Bunker silo ownership costs = $0 scenario			
Total cost of silage into storage, $/ton AF	$26.22	same as scenario A	
Total cost of silage into storage, $/ton DM	$81.93	same as scenario A	
Total cost of silage out of storage, $/ton AF	$34.05	same as scenario A	
Total cost of silage out of storage, $/ton DM	$106.40	same as scenario A	
Silage cost adjustments due to quality			
Milk prod. adjusted cost of silage out of storage, $/ton AF	$34.05	same as scenario A	
Milk prod. adjusted cost of silage out of storage, $/ton DM	$106.40	same as scenario A	

bags, then this value reflects the structure cost associated with bagging systems. The cost of packing can be estimated based on tractor-hours used for packing or custom rates for packing. Generally, as packing cost is reduced, packing density also is reduced resulting in higher dry matter losses. Therefore, modifying packing cost or dry matter losses should result in changing the input value of the other parameter (i.e., these two inputs are not necessarily independent of each other). Custom rates are the relevant cost to use if custom operators are used to bag silage. The relevant cost for dairies owning bagging equipment include the cost of depreciation, interest, repairs, labor, and fuel associated with the equipment or these costs may be approximated using custom rates.

Storage losses – Storage losses represent dry matter (DM) loss during storage and silage removal. Values will vary between dairies due to management styles.

Quality losses (milk production adjustments) **–** DM loss may be greater for bunkers and piles than it is with bags because of silage spoilage. If silage out of a bag is higher quality than silage out of a bunker or pile, this difference could result in an extra pound of milk production per cow per day. The cost of the silage fed must be adjusted to account for this increased income.

Based on the input assumptions in *"Comparion of Economic Costs – Example Dairy"* (above), Table 2 shows the economic comparisons of the three methods to store silage as calculated using the SilageStorage$.xls spreadsheet for two scenarios. Scenario A represents full costs for all structures and Scenario B represents no ownership costs charged to the bunker silo (i.e., bunker is already in place and thus these costs are fixed).

In Scenario A, annual cost of the structure is considerably higher for the bunker silo compared to drive-over piles and plastic bags because of the initial investment in concrete. The total cost of silage going into storage – which accounts for structure costs, cost of silage, packing, bagging, and plastic – is highest for the plastic bags and lowest for the drive-over pile.

Cost coming out of storage accounts for dry matter (DM) losses and is higher for bunkers and lowest for bags because of lower DM loss. The cost of silage coming out of piles is only slightly higher than for bags. In this example, storing silage in bags is about $1.50/ton less than piles and $16/ton less than bunkers without any impact on milk production.

If DM loss of the piles and bunkers were equal (23%), DM cost of silage out of the piles decreased to $117.94, which was slightly less than silage out of bags (data not shown). This reinforces how important it is for a dairy to make comparisons using their own numbers.

If silage coming out of the bag is of higher quality and increases milk production 1.0 lb/cow/day, relative to silage out of bunkers or piles, the cost per ton on a DM basis decreases almost $17. This large change in cost per ton reinforces why it is important to calculate a milk-production-adjusted cost per ton when considering alternative storage systems if indeed there will be impacts on production.

Given that a dairy might already have a bunker and thus this "structure cost" is fixed, how does this impact the analysis? In this case, the appropriate thing to do for comparing bags to bunkers would be to zero out the annual cost of the structure and land and focus only on variable costs. Scenario B in Table 2 shows cost comparisons assuming the annual costs associated with structures and land for the bunkers are $0, and drive-over piles and plastic bags still have costs of $2.91 and $2.99/ton, respectively (assumes you still need to develop an area for piles or bags).

In this case, cost per ton of DM silage out of the bunker is less than that out of piles or bags ($106.40 vs. $121.37 and $119.87). Thus, in this scenario the extra milk production is needed if bags are going to be lower costing than bunkers. It should be pointed out that this scenario is not sustainable in the long run because eventually the bunkers would have to be replaced.

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Summary

The most important point of this analysis is how much costs per ton will vary depending on the assumptions. Costs per ton of milk-production-adjusted silage were compared for silage stored in concrete bunkers, drive-over piles, and plastic bags for an example dairy. Cost per ton was lowest for silage stored in bags if all costs were included for the bunkers. However, if fixed costs of concrete bunkers were ignored, the cost of storing silage in bags was only lower than silage stored in bunkers if milk production for cows fed bagged silage increased slightly. To aid dairy managers with evaluating their silage storage alternatives an Excel computer spreadsheet (SilageStorage$.xls) has been developed that can make this process much easier.