The Big 6 – Focus on the 6 Keys to Quality Corn Silage

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Introduction

Corn silage is an important source of forage in the United States making up over 40 % of the value of the forage fed to dairy cows. It is also an important feed in the beef finishing industry. Corn silage production requires careful attention to detail in order to maximize potential return as a high quality feed. There are six key factors, *The Big 6* that, when focused on properly, can help producers harvest, store, and feed high quality silage and minimize shrink loss while maximizing milk production. This paper will review each of these key focus areas.

The Big 6

1. **Hybrid Selection**
   - Select hybrids with a proven track record for good feeding quality plus good yield *(milk per ton, milk per acre).* Select traits that will help maximize total productivity.
2. **Harvest Timing**
   - Harvest at the proper timing to maximize yield, quality, and proper fermentation.
3. **The Proper Chop**
   - Make sure that chop length is set for the theoretical length of cut that fits the ration needs.
4. **Focus on Density - Pack, Pack, Pack**
   - Pack based on delivery rate. Shoot for 15 lbs/ft^3 density or higher as a benchmark**.**
5. **Plan for Enough**
   - Make sure you have enough inventory and wait 3 to 4 mo to begin feedout for highest quality.
6. **Cover and Seal**
   - Cover as quickly as possible to reduce spoilage.

Hybrid Selection

Corn hybrid selection is one of the most important management decisions in silage production. A hybrid selected today will not impact milk or meat production for typically over one year after that decision is made, and the resulting feedstuff must be utilized whether it produced poor or top quality feed. Selecting the correct hybrid can often mean the difference between breaking even and making a profit.

Selecting hybrids for silage production depends somewhat on whether a field is planned specifically for silage or whether the field may be harvested for grain (ie. dual purpose). Silage types should have high forage yields, high total digestibility, low fiber levels, and highly digestible stover. The best silage types have high grain yields, because grain is so highly digestible and adds greatly to total dry matter (**DM**). However, rankings for top-yielding hybrids used for silage may vary based on differences in fiber digestibility and grain-to-stover ratio.

A dual-purpose hybrid should have both high grain and forage yields. For both scenarios, hybrid selection should start with identifying a group of hybrids that are agronomically adapted to the region in terms of maturity, disease and insect resistance, and drought tolerance; and may contain valuable biotech traits for insect protection or weed control flexibility. All of these factors will play a role in enhancing the productivity and profitability of corn grown for silage.

Generally, it is a good practice to build a package of several hybrids in a silage production plan. This will help to spread harvest and agronomic risk as well as maximize long term yield. In areas with short growing seasons, hybrids selected should consistently reach harvest maturity just before frost. Other factors, such as feed requirements, harvest timing, and the potential of wet soils at harvest may dictate the selection of earlier maturing hybrids. Growers using a dual-purpose strategy may need to plant some fields to the adapted maturity to assure ripening and a limited acreage to the later types for corn silage.

Once a group of adapted hybrids is identified, evaluate them on the basis of yield and nutritional quality potential. For those fields that are planned for silage production only, evaluate hybrids based on silage yield performance. Many studies have shown that grain yield is a good general indicator of whole plant yield; that is, high grain yielding hybrids tend to have high silage yields. However, within the high grain group, there can be differences in whole plant yield and fiber digestibility, reinforcing the need to have silage data available on these hybrids. For the dual-purpose strategy, select hybrids with good grain and silage yields.

The final consideration for hybrid evaluation should be nutritional quality. Significant differences exist among commercial corn hybrids for digestibility, **NDF** (neutral detergent fiber), NDF digestibility, and protein. Most studies have shown that within a group of commercial hybrids, there will be a few with superior quality, most with average quality, and a few with significantly less than average quality.

Predicting animal response and relating it to improvements in corn silage quality is complex. Differences in quality can translate into differences in animal performance. The optimum silage composition can vary depending on the type of cattle being fed and on other components of the ration. For example, a high grain or high starch corn silage may be best in a finishing ration or in a dairy ration that contains a lot of good quality forage. But in a dairy ration where corn silage makes up the bulk of the ration, the same high grain corn silage may not be as desirable as a high energy, low grain silage. The best estimates of animal performance responses and supplementation costs can be obtained through forage analysis.

One approach to combining yield and quality information to aid in hybrid selection is to estimate a value of the milk production potential of a hybrid. The Milk2000 formulas developed at the University of Wisconsin can be used to do this. Milk2000 utilizes laboratory forage analysis along with yield information to create an index of the potential milk productivity differences between corn hybrids. Milk2000 calculates an estimate for milk/t, or the amount of potential milk production from one ton of silage of a particular hybrid based on the measured quality parameters. The calculation of milk/t assumes an average standard cow body weight of 1350 lb and a milk production level of 90 lb/d at 3.8 % fat. Milk2000 also uses university research to estimate dry matter intake (**DMI**) based on fiber digestibility (**NDFd**), which has been shown to have a significant impact on milk production. Past research has shown that a 1 % change in fiber digestibility can influence DMI by over 0.26 lb/d, equating to nearly ½ lb of milk/c/d. At this point the program also calculates milk/A, or how much potential milk production can be predicted from one acre of corn silage from a given hybrid. Milk/A builds in the economic influence of yield by multiplying the quality component (milk/A) and the DM yield of the hybrid per acre. The trade-off between yield and quality in selecting hybrids for corn silage production is based on the value placed on silages of different nutritional composition. ***Bottom line…*** the best economical return will likely be achieved with hybrids that show a good balance between a high milk/t (quality) and a high milk/A (yield & quality).

Specialty Corns for Silage

Specialty hybrids for corn silage have unique physical or chemical characteristics which may affect their forage value. These include *leafy*, brown mid-rib, waxy, high oil, and high lysine hybrids. Enhancing nutritional value or yield is the primary reason for the development of these hybrids. Table 1 shows some of the relative forage quality characteristics of these hybrids. In many cases, these hybrid types are poor choices for silage due to reduction in yield or weak agronomics, such as drought tolerance or standability.

Leafy hybrids

- Most corn plants develop 18-21 leaves (6 to 8 above the ear), but by harvest only 15-17 leaves remain.
- In an attempt to enhance silage yield, *leafy* hybrids have been adapted to have an extra three to four leaves above the ear, and these are progressively smaller.
- Leafy hybrids will typically produce less grain.
- Leaves are slightly more digestible than stalks. However, they do not meet the energy value and tonnage supplied by the grain.
- Pound for pound, grain has more megacalories of net energy for lactation (**NE_L**) than leaves.
- As a general rule, it takes about a 6 bushel/A grain yield advantage to equal the energy value of four extra leaves on every plant.
- *Leafy* hybrids are not currently available with potentially valuable biotech traits.

Brown midrib (BMR^3)

- BMR^3 is a mutation in corn that produces a reddish-brown color to the leaf midrib, thus the name.
- The BMR^3 mutation causes hybrids to produce less lignin and altered lignin composition, which increases the fiber digestibility of the plant stover.
- BMR^3 mutants typically yield 10 to 15 % less than conventional hybrids grown for silage.
- BMR^3 hybrids pose increased agronomic risk due to less disease tolerance and wide environmental adaptability.
- BMR^3 hybrids are specific for SILAGE ONLY and make very poor grain or dual purpose type options.
- BMR^3 hybrids are not currently available with potentially valuable biotech traits.

Waxy hybrids

- Waxy corn is a recessive variant of conventional corn and was identified in China in 1908.
- Waxy hybrids contain 100 % amylopectin starch. Conventional hybrids will contain about 75 % amylopectin starch and 25 % amylose starch.

- Waxy hybrids are used by the corn wet milling industry for the production of cornstarch products and high fructose corn syrup and are usually grown under contract.
- University feeding trials have shown that waxy hybrids have no advantage for milk production and are typically equal to conventional hybrids for both yield and quality.
- Waxy hybrids are not currently available with potentially valuable biotech traits.

High oil hybrids

- High oil corn contains approximately 7 to 8 % oil in the grain, which is about a 2 to 3 % increase over conventional corn.
- The grain from high oil corn will typically have a larger germ size, but results in the displacement of starch in the kernel.
- Whole plant silage yield is typically lower with high oil corn and agronomic adaptation can be an issue with some hybrids.
- Producers also need to compare the economics of substitute fat sources to that of oil from corn hybrids.
- Typically, a 2 % increase in kernel oil equates to a 1 % increase in oil in whole plant corn silage.
- University research trials have shown a milk production increase when feeding high-oil corn ***grain***; however, little or no benefit has been observed to feeding high-oil corn silage.
- High oil hybrids are not currently available with potentially valuable biotech traits.

High lysine hybrids

- High lysine hybrids contain increased levels of the two amino acids, lysine and tryptophan.
- Hybrids with elevated levels of lysine do not show a benefit in cattle due to the susceptibility of the amino acid to breakdown in the rumen.
- Lysine and tryptophan are essential in the diets of non-ruminants, such as swine and poultry.
- No advantage has been observed in utilizing high lysine corn for silage.
- High lysine hybrids are not currently available with potentially valuable biotech traits.

Harvest Timing

Corn should typically be harvested for silage between 60 and 70 % moisture content to ensure good storage and fermentation in the silo. Recommended harvest moistures will vary depending on the storage structure. Follow the moisture guidelines for the specific storage structure to promote good packing and minimize losses due to heating or runoff.

A rough estimate of proper whole plant moisture for harvest can be made using the kernel milk line. The *milk line* (Figure 1) is the divide between the milky sugars in the maturing kernel and the starch, which is the storage form of those sugars. It is actually a weak relationship between the milk line stage of the corn grain and the whole plant moisture, which can vary as much as 25 % at ½ milk line depending on the hybrid and the growing environment. Use the 1/3 milk line stage as a *trigger* to start checking whole plant moistures to determine the optimum timing for silage harvest. The milk line can be visually inspected by breaking an ear of corn in half with the ear tip in your right hand. View the portion in your right hand. Notice that the starch develops from the top of the kernel (at the dent) and progresses to the tip attached to the cob. The starch line is an indicator of grain maturity, typically moving down the kernel at about ¼ of its length per week. Use the chart (Table 2) to help predict the amount of time it will take to get from the early grain stages to half milk line. This should help when planning which fields will need to be chopped first for optimum moisture.

Table 1. Range in relative dry matter yield and forage quality characteristics of dent corn and other corn germplasms[1].

Specialty Hybrid	DM Yield (relative to dent corn)	Digestibility	Crude Protein	Fiber ADF : NDF
		----%----	----%----	----%----
Dent corn	100	49-72	7-11	23-43 : 40-68
Brown mid-rib	81-90	56-69	7-10	21-39 : 37-65
Waxy hybrids	96-114	69	8-11	22-37 : 41-57
High oil hybrids	---	71	9	--- : 40

[1] Adapted from Lauer, 1995.

Measuring Moisture Content with a Microwave Oven

Follow these instructions to determine the moisture content of corn silage using a microwave oven.

- Weigh out exactly 100 grams or a pre-determined weight of fresh silage on a paper plate. (Don't forget to adjust for the weight of the paper plate.)
- Spread the forage evenly on the plate and place in a microwave oven.
- Heat on high for 4 minutes.
- Remove the silage, weigh and record.
- Heat the sample again on high for 1 minute. Weigh and record.
- Repeat this procedure until the weight remains the same.

At this point, the *stable* weight represents the DM content of the silage. To calculate the moisture content, subtract the DM content from 100.

Example: Starting with a 100 gram sample, and after several heating cycles, the sample weight stabilizes at 34 grams. Thus, the DM is 34% and the moisture is 66% (100-34).

Timing for whole plant moisture is critical for silage harvest and is best determined by taking plant samples, weighing them, then drying them in a Koster tester, microwave oven (see sidebar), or other type of dryer and then weighing them again to determine total moisture. If the corn is chopped too wet it will go through a poor fermentation and the added moisture will enhance the seepage of valuable nutrients from the bunker. Seepage primarily removes *high value* nutrients like soluble protein and carbohydrates. If the corn is harvested too dry, fermentation will be inconsistent, which promotes mold development, less digestible grain and fiber, and poor bunk life. Often, adding water to overly dry corn silage is impractical because of the amount of water needed. For example, a 4000 lb load of silage at 45 % DM would require 137 gallons of water to get it to 35 % DM. However, if an easily accessible, high volume water source is available, adding water to dry corn silage during silo filling has been a valuable practice for some producers.

Table 2. Average time required for corn grain to reach ½ milk line from various growth stages.

Growth Stage	Days to ½ Milk Line (Average)
Blister	25-35
Late milk/dough	15-25
Early dent	5-15

Nutritional components must also be considered when timing the harvest of corn silage, because as the corn plant matures, the composition of the plant changes. More mature corn silage will be composed of drier grain with harder (less digestible) starch and seed coats, higher starch quantity and less sugars, and less digestible fiber than earlier harvested corn. Overly mature corn silage also contains lower amounts of vitamins A and E As harvest is delayed from full dent to black layer (no milk line) crude protein levels decline, fiber levels either remain constant or decline, and digestibility remains relatively constant.

Therefore, for harvest timing consideration, harvesting early will yield more digestible stover and less starch (from lower percentage of kernels), while harvesting later (⅔ to ¾ milk line with some brown leaves) will result in nearly the same whole plant digestibility; however the energy content of the silage is coming from an entirely different source (starch from the kernels), which can change rumen dynamics. The desired feeding program may influence the maturity and storage facility you choose for your corn silage.

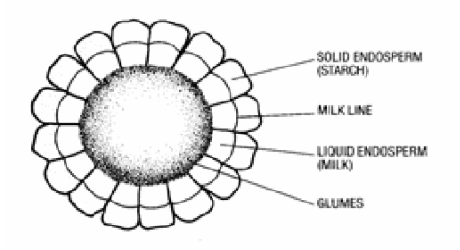

Figure 1. Cross section of the tip half of the corn cob showing milk line progression down the kernel.

The Proper Chop

The ideal theoretical length of cut (**TLC**) for corn silage will depend on a variety of factors including whole plant moisture at harvest, hybrid selection, storage facility, kernel hardness, forage processing, and feeding practice. In regards to chop length, nutritionists will often say, "the cow prefers it long, but the machine wants it short". The key to the ideal chop length is to strike a balance between the best length for packing and silo fermentation and for optimum rumen health and function. If a high percentage of the silage particles are too long (> 20 % over ¾-inch) then there will likely be problems with packing and oxygen exclusion resulting in poor fermentation and storage in the bunker.

If there are a high percentage of finely chopped particles (50 % or more smaller than 1/3-inch) then there will likely not be enough effective fiber in the feed ration, which can result in rumen health problems such as acidosis and reduced butter fat. If the corn silage will be included as part of a **TMR** (Total Mixed Ration), then increasing the chop length may allow for the harvest and feeding of alfalfa with a shorter chop length. Care should be taken to not overmix the TMR, which can compromise the amount of effective fiber in the ration. A great way to evaluate your chop length is to check the particle size mix with the Penn State particle size separator as the silage is being harvested. Guidelines for the optimum percentage of differing corn silage particle sizes in each sieve is found in Table 3.

When corn silage is not the sole forage in the ration, then 2 to 4 % of the sample remaining on the top screen may be adequate with a 3/8-inch TLC. Large cob *disks* that remain in the top screen will typically be sorted and refused by the animals and therefore do not contribute to the effective fiber consumed in the ration. In general, for corn silage chopped by a harvester with a kernel processor, research indicates that the optimum average chop length should be ½ to ¾ of an inch, with about 15 to 20 % of the courser particles remaining in the upper sieve of the Penn State shaker box. This will produce the best balance between good silo fermentation, optimum rumen function, and maximum animal performance.

Focus on Density - Pack, Pack, Pack

Minimizing shrink on forages is a key factor to improving profitability and forage quality on our dairies. Getting adequate pack or density on forage piles and bunkers is a key to reducing shrink. Ruppel et al. (1992; Table 4) showed that corn silage DM loss in bunker silos after 180 days of storage was reduced from 20.2 to 10 % as density was increased from 10 to 22 lb DM/ft^3. We have seen increases in the delivery rate of corn silage to bunkers and, in particular, to piles in recent years as the sizes of the dairies have increased. What is not certain is if enough packing tractors are being used to get the desired minimum pack density of 15 lb DM/ft^3.

Conducting the Survey

Packing densities of bunkers and piles were collected on 40 dairies in three states (MN, WI, and IA; Figure 2) from May to August, 2005. We used a 2 in. diameter by 24 in. long stainless steel core sampler powered by either a gas-powered drill or by an 18 volt ½-inch drill. We sampled across the face of the bunker or pile 3 ft above the floor, 2 ft below the top edge, and in the middle of these two levels. At each level we sampled approximately 4 to 6 ft from the edges of the bunker walls. Samples for the edges of the piles were taken at distances approximating 20
to 25 % of the total width of the piles. A center sample was taken between the two side samples in both bunkers
and piles. An example of sample locations for a pile measuring 160 ft wide starting at the left side of the pile would be 40 ft (left side), 80 ft (center) and 120 ft (right side). A total of 334 core samples were taken to determine density (Table 3). We combined the samples from each layer and determined DM content.

Results of the Survey

Data were analyzed using PROC MIXED of SAS software. The effects of storage structure (bunker vs. pile), vertical layer (top, middle, and bottom), horizontal layer (left, center, and right), and all interactions on packing density were determined. There were no interactions among storage structure, vertical, and horizontal layers; therefore, only main effects are presented.

Table 3. Guidelines for forage particle size distribution in corn silage*(Using the Penn State Particle Size Separator).*

Screen	Pore Size (inches)	Particle Size (inches)	UN-PROCESSED Corn Silage % of Sample	PROCESSED Corn Silage % of Sample
Upper sieve	0.75	> 0.75	3 to 8	15 to 20
Middle sieve	0.31	0.31 to 0.75	45 to 65	45 to 65
Bottom pan		Less than 0.31	30 to 45	20 to 35

Table 4. Corn silage dry matter loss in bunker silos of different density.

Silage Density (lbs DM/ft^3)	DM Loss at 180 days (%)
10	20.2
14	16.8
15	15.9
16	15.1
18	13.4
22	10.0

***Source:** Ruppel et al., 1992*

Table 5. Number of farms surveyed for packing density by state.

	IA	MN	WI
Bunkers	10	6	11
Piles	1	7	5

Regardless of storage structure, average density achieved was 13.8 lb DM/ft^3. Average packing density for bunkers was numerically (P = 0.17) greater than that of piles (14.1 vs. 13.0 lb DM/ft^3, SEM = 0.58). One possible explanation might be that piles often have a higher delivery rate simply due to the ease of dumping trucks from any side of the pile. Significant differences were observed for both vertical (Figure 4) and horizontal (Figure 5) layers. Packing density decreased (P < 0.05) from 15.2 lb DM/ft^3 in the bottom layer to 13.7 and 11.7 lb DM/ft^3 (SEM = 0.44) in the middle and top layers, respectively, for both bunkers and piles. This clearly indicates the importance of packing silage into 6-inch layers to maintain optimal density as the pile grows in size. In addition, the reduced density in the top layer promotes surface spoilage. Packing densities observed in the centers were greater (P < 0.05) relative to the left and right sides (14.3 vs. 13.3 and 13.0 lb DM/ft^3; SEM = 0.44). Two factors are likely responsible for this effect: 1) safety and 2) operators are preventing damage to the bunker sidewalls or the plastic lining the sidewalls.

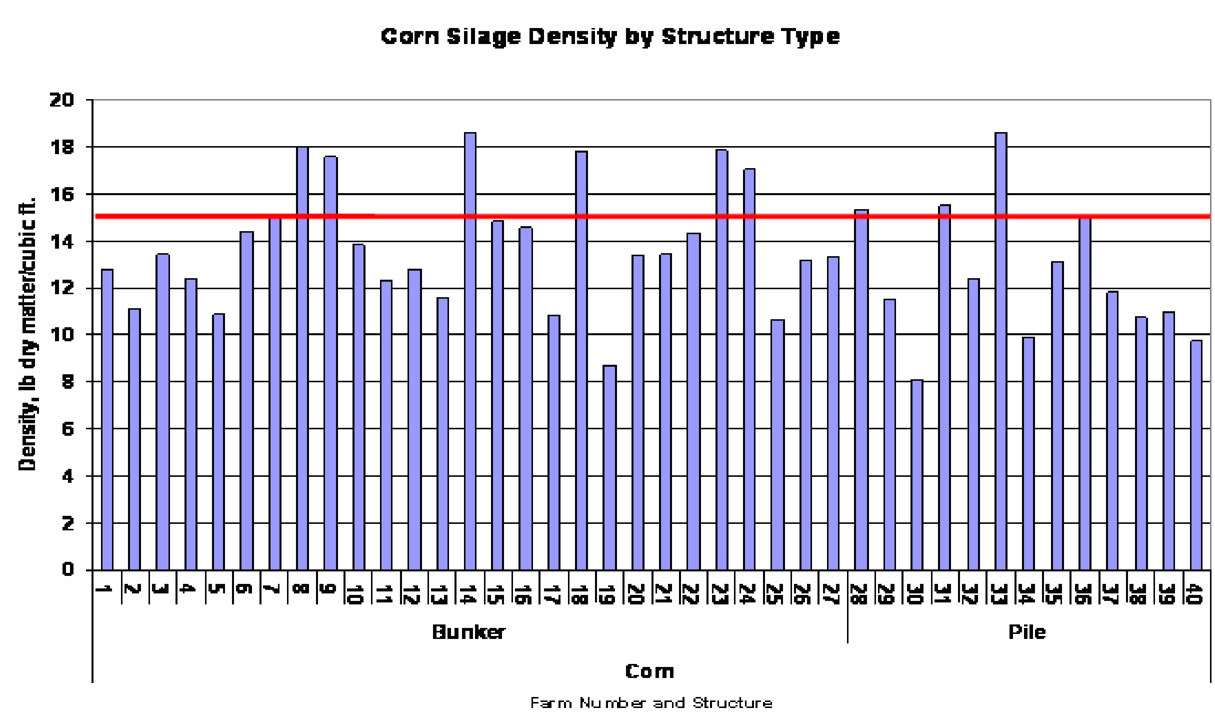

Figure 2. Corn silage density on 40 farms by structure type.

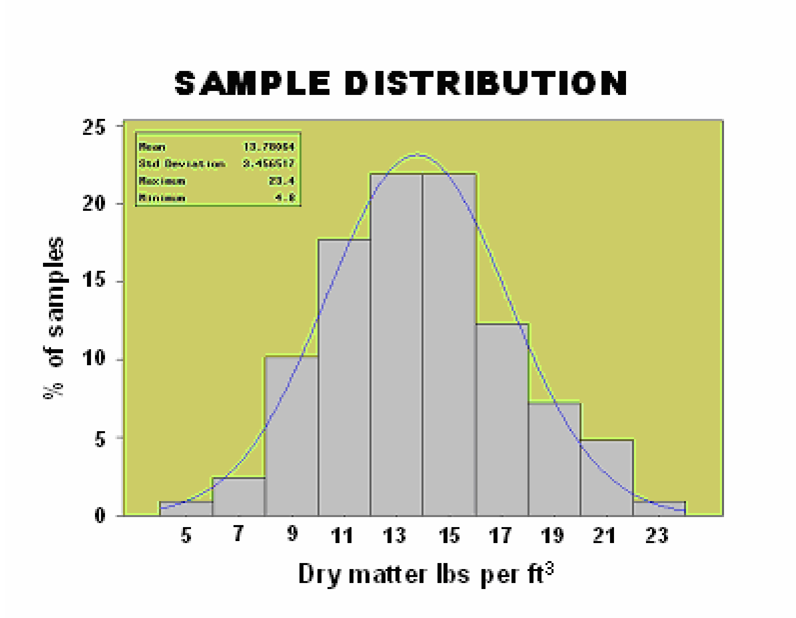

Figure 3. Distribution of corn silage density on forty farms, illustrating that 22.5% of surveyed dairies were at or above the 15 lb/ft^3 density benchmark.

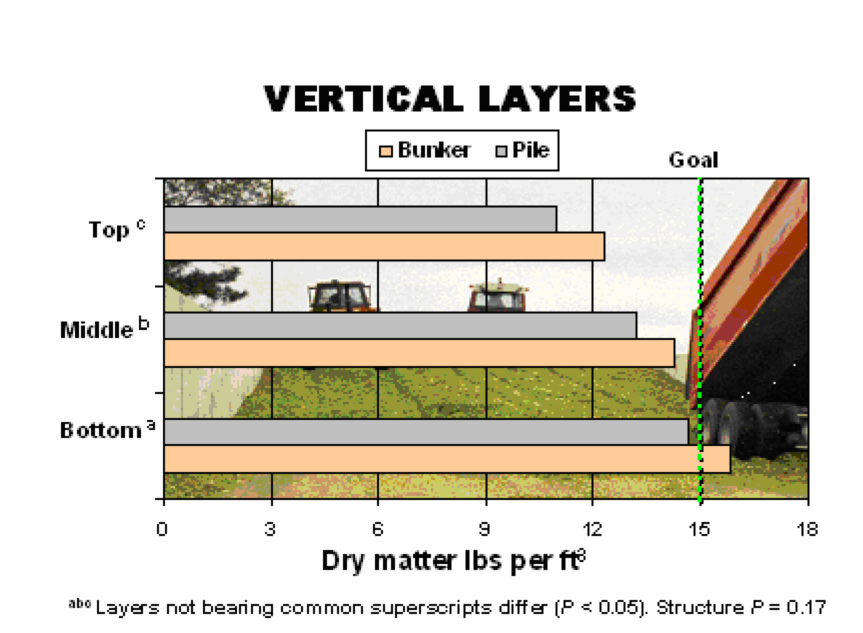

Figure 4. Average packing density achieved in bunkers and piles in the top, middle, and bottom layers.

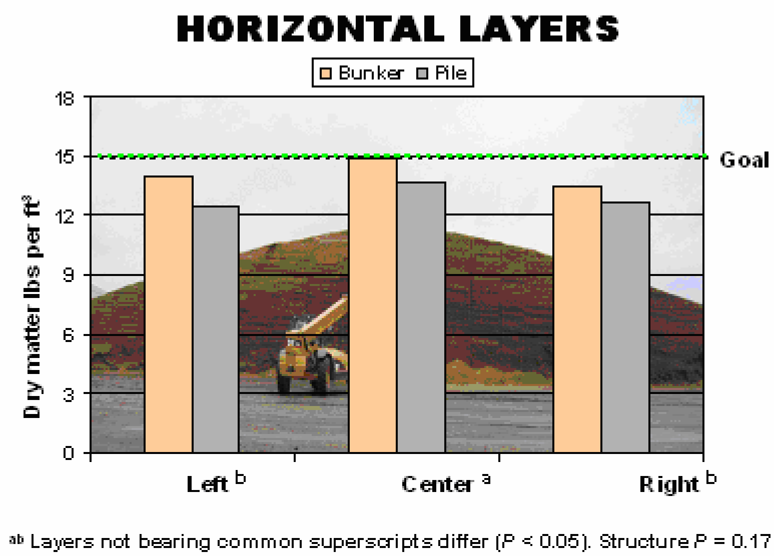

Figure 5. Average packing density achieved in bunkers and piles from the left, center, and right layers.

Table 6. Percent feeding loss by silage storage system.

Storage System	Feeding Loss (DM %)
Bunker/silage bag (less than 5"/day)	11
Bunker/silage bag (more than 5"/day)	5
Tower silo (haylage)	11
Tower silo (corn silage, whole plant)	4

Source: *Penn State University*

Key Points of DM Loss

When storing corn for silage, oxygen (and the bacteria that utilize it) is the mortal enemy. These bacteria are the enemy to silage because in the process of utilizing the trapped oxygen in the bunker or pile, they *burn* energy (DM) to grow and multiply, and thus reduce overall silage yield. There are two key points where this *shrink* loss occurs, at storage and feedout. With the cost of producing and harvesting corn silage, the loss of DM can have a significant economic impact and should be minimized; if possible, primarily through good storage and feedout management practices. Here's a closer look at the primary points of DM loss.

DM Loss #1.

Silage shrink at the bunker during storage and ensiling. Dry matter lost through this process can be significantly reduced by forcing as much oxygen out of the pile as possible before the bacteria can utilize it. This is done through good packing practices as the silage is delivered to the storage structure and by increasing the overall compaction density. A good rule of thumb is to pack to a density of 15 lb DM/ft^3 or greater to minimize DM loss. Table 4 shows various silage packing densities and the typical DM loss associated with them.

DM Loss #2.

Silage shrink at the bunker during feedout. Dry matter losses also occur during feedout with any silage storage system. Maintaining anaerobic conditions within the storage structure are critical for long-term stable silage storage. Once the structure is opened and silage re-exposed to oxygen, DM losses will begin to occur more rapidly. A smooth, firm silage face and feedout at an appropriate rate is key to reducing this form of DM loss. Table 6 indicates the average percent feeding loss for silages stored in specific structures.

Economic Impact of Proper Packing

It is important to note that just 22.5 % of the surveyed dairy's (9 total) averaged at or above 15 lb/ft^3 benchmark for adequate density. Utilizing the density data from the 334 individual samples collected through this survey, it is possible to construct an example of an average producer and the predicted DM loss associated with his/her current storage and feedout practices, compared to the *best case* producer, as sampled during this project, with an average bunker density of 19.25 lb DM/ft^3. Here is an example of the economics associated with this comparison.

Table 7. Example analysis of the cost of shrink between average and *best case* scenarios found in the density survey.

Location of DM Loss	Current Practice	Best Case from Survey[1]	Difference	$ Value Lost per Ton[2] (@$20/t)
Bunker shrink	18.5% (@12 lb DM/ft^3)	12.3% (@19.25 lb DM/ft^3)	6.2%	$1.24
Feedout Shrink	6.5%	5%	1.5%	$0.30
Total Shrink	25%	17.3%	7.7%	$1.54
Lb Lost in 25 t of Silage/A	12,500 lb (6.25 t)	8,650 lb (4.33 t)	3,850 lb (1.93 t)	
Value of DM Lost/A @ $20/t	$125.00	$86.60	**$38.60**	

Source: *Oelberg, Harms, Ohman, Hinen and Defrain, 2005*

[1] *Survey packing densities on 40 dairies in Iowa, Minnesota and Wisconsin during May to August 2005.*

[2] *DM loss would be significantly higher than $20 per ton because the loss comes primarily from soluble starch and protein rather than from fiber.*

Example: An average producer harvests and stores corn silage in a bunker silo and is able to get it packed to a density of 12 lb DM/ft^3. His feedout practices are good; however some excess silage that does not get fed each day is apparent and the face management at the bunker could be improved. His average yield for corn silage is about 25 t/A and the current price for corn silage out of the field in his area is $20/t. Table 7 is a comparison of this producer's predicted DM loss to the real life *best case* and the associated economic impact. At an assumed yield of 25 t of silage/acre at a cost of $20/t harvested, the difference in corn silage value lost through this producer's current silage management practices compared to that of a *best case* producer from the survey is $38.60/A. In more telling terms, if this producer harvests 500 A of corn silage/yr, this would equate to a loss of $19,300/yr, or the cost of 772 t of silage.

The quickest and easiest way to reduce this producer's lost value is to improve his packing and storage practices. As a point for thought, by using the $19,300 in lost DM value in the example and a tractor rental rate of $0.22/hp hr (ie. 100 hp tractor costs $22/hr), this producer could afford to rent two, 200 hp tractors for additional packing and afford to operate them for 219 hr to improve packing density and reduce lost value.

The value loss in this example is only that realized by direct reduction in loss of silage DM. What is not captured here is any additional dollar's lost through feed spoilage organisms and their subsequent effect on reduced DMI by the animal and the related loss in milk production, which can be significant. Additional points of potential DM loss such as covering practices and feed refusal/discard have also not been considered here.

Good packing technique will ensure a high density silage and can increase the storage capacity of the structure by up to 40 %. When sampling a silage stack for density, at or above 15 lbs of DM/ft^3 is a good benchmark to shoot for. As a general guideline, to achieve a good pack density, allow for at least 5 minutes of packing time per ton of wet forage.

Plan for Enough

Research has shown that the quality of corn silage will improve over time after it has properly fermented. Fiber will typically become more digestible and starch and protein become more available (Table 8) the longer silage *bathes* in the fermentation acids that are a result of the ensiling process. It is not known exactly why this phenomenon occurs, but may be due to several factors including more complete hydration of corn kernels, continued acid hydrolysis, and continued enzyme activity in the silage pile. In order to maximize the quality of the corn silage fed, it is best to plan for a minimum of 3 to 4 mo of carry over silage from the previous year's harvest. This requires some advance planning and density measurements, as described earlier, which should be used to predict inventory. In short, properly fermented corn silage that is retained in storage for at least 120 d will have more available energy, protein, and more digestible NDF.

Table 8. Changes in nutritional components as storage time increases.

Time in storage, days	Sol CP, % of CO	RFS[1], %	Effective ADF[2], %
45	50.2	49.0	70.0
90	50.8	51.1	---
135	52.7	53.6	---
180	55.0	24.4	63.0
280	61.9	60.1	56.0

[1] RFS = Rapidly Fermentable Starch (@ 2h), % of starch
[2] Effective ADF, % of ADF
Source: Provimi, French research agency

Cover and Seal

Covering and sealing corn silage can prevent substantial DM losses during ensiling. In addition, the resulting silage has a higher digestibility. It has been estimated that covering a bunker silo with plastic can return $8 for every dollar spent due to reduced losses and increased animal productivity. One of the key's is to fill and cover the silage as quickly as possible after harvest and packing. There are a wide variety of materials on the market today used for covering corn silage, including the new reduced oxygen permeable plastics, which have been shown to significantly reduce top spoilage. At the minimum, it is recommended to use a standard 4 mm plastic if storing silage less than 3 mo or 6 mm plastic if storing longer and place 15 to 20 tires per 100 ft^2 to hold down the plastic.

Conclusions

Harvesting and storing high quality corn silage requires careful attention to six key areas in the process. Minimizing shrink on forages is a key factor to improving profitability and forage quality. Getting adequate packing density on forage piles and bunkers is a imperative to reducing shrink and increasing economic return on overall feed cost. The results of the silage density data presented in this paper clearly show's that more care needs to be paid to proper packing and feedout practices at many dairies today. If a producer focuses on *The Big 6*, there is a high probability that DM loss will be minimized while milk production potential from the feed will be maximized.

Remember "The Big 6"

1. **Hybrid Selection**
   - Select hybrids with a proven track record for good feeding quality plus good yield *(milk per ton, milk per acre).* Select traits that will help maximize total productivity.
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   - Pack based on delivery rate. Shoot for 15 lbs/ft^3 density or higher as a benchmark**.**
5. **Plan for Enough**
   - Make sure you have enough inventory and wait 3 to 4 mo to begin feedout for highest quality.
6. **Cover and Seal**
   - Cover as quickly as possible to reduce spoilage.

Literature Cited

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