PIONEER® BRAND · PRODUCTS

Making your silage and high moisture grain programs more profitable

Nutritional Sciences

More emphasis is being place on **management** by the feeder/producer today than ever before. As a beef, dairy or pork producer, you are looking for cost effective ways to make all phases of your operation more efficient. Silage or high moisture grain management has a significant impact on your bottom line.

Knowing what makes quality wines and cheeses can help you make better silage.

What do wine and cheese have in common with silage? All are products of fermentation and depend on bacteria to convert milk, juice or forage into cheese, wine or silage. The quality of each of these end products greatly depends on the quality of the fermentation that takes place.

In the silage making process, bacteria convert plant sugars to acid, which preserves the silage. When enough acid has been produced, the bacteria that caused the fermentation die or become dormant and the process ceases. **The faster the fermentation is completed, the more nutrients will be retained in the silage.** The following management information will help you get the most out of the silage and high moisture grain you feed your animals.

Inoculation… The Natural Step

Following all the recommended management steps that are outlined here will not automatically assure you of top quality silage or high moisture corn. Research has shown that nature does not always provide enough of the right bacteria for fast, efficient fermentation. There is one management step available that will help: inoculating with Pioneer® brand Inoculants.

Pioneer researchers have selected the best strains of live bacteria that will produce superior quality forage. The bacteria strains in Pioneer inoculants are genetically selected on the basis of their ability to improve fermentation and enhance the nutritional quality of the silage. The strains in Pioneer inoculants produce complex sugars, which help bind free water and reduce run-off. When added to your forage, Pioneer inoculants get the fermentation started sooner and finished faster… with less waste caused by spoilage organisms. The result is ensiled forages that retain more digestible nutrients and dry matter. Other benefits you can expect include improved palatability, easier unloading from the silo and less winter freezing.

Numerous research and field trials conducted at Pioneer and

Estimated Losses from Various Storage Systems Under Good Management

SOURCE OF DRY MATTER LOSS	Storage System and Crop DM Content at Harvest				
	Horizontal trench or stack (35% DM)	Horizontal bunker (35% DM)	Concrete tower (35% DM)	Oxygen-limiting tower (55% DM)	Bag (35% DM)
	% of the Standing crop DM in the field				
Respiration and weathering	4	4	4	6	4
Harvesting	2	2	2	3	2
Storage	15	12 (10-15)	9 (8-9)	5	7 (5-9)
Feedout	4	4	2	2	4
Total	25%	22%	17%	16%	17%

Source: Harrison 1991/Alberta Agriculture 1988 *Figure A* university facilities have shown the advantages of inoculated silage and high moisture corn. The higher feed quality offers you the management edge that can add up to more meat or milk from your forage acres.

Key management principles that apply to fermentation with any crop.

Sufficient moisture – The bacteria that can create a desirable fermentation need water to live, grow, and produce acid. Having enough moisture also speeds chopping and enables you to expel the air in the silo more effectively. Sixty-five percent moisture is a good average. A moisture test of your present silage might help you determine if you need to consider management changes. It is essential to collect a **representative** sample to assure an accurate moisture test.

Maturity – Plants should have sufficient maturity and strength so the plant cells can resist crushing in the silo that can cause seepage. Plants should also have sufficient maturity to assure an adequate nutrition return from each crop acre.

Often maturity and moisture are "trade-offs". Forage sorghums, for example, contain an adequate level of nutrients at the early dough stage. But harvest is usually delayed until the lower leaves start to turn brown in order to avoid seepage.

Proper Cutting – Keeping knives sharp and the shear bar properly adjusted will save fuel. This will also damage less plant cells, reducing seepage risks. A reasonably short, uniform cut makes packing easier.

Compaction – Use your heaviest wheel tractor for packing a bunker. It is especially important to have enough plant moisture for a good pack. For upright silos use a distributor.

Fill quickly – Fill your silo fast to minimize exposure to air.

Cover with plastic – Cover bunkers or upright silos with plastic when filling is completed to prevent silage from being exposed to air and rain water. Take care to weight down the outside perimeter of the plastic. In upright silos, weigh down the plastic with several inches of wet forage or dry grain – the latter can be fed out when you open the silo. For bunkers or stacks, plastic is best weighed down with old rubber tires. Put on as many as you can.

Preparation for Silage Chopping

- Inspect silo or bunker and repair any air leaks. Repair damaged doors on upright silos.
- Sharpen knives and adjust shear bar on chopper daily.
- Adjust speed and check clearance of fans on chopper and blower.
- Eliminate potential bottlenecks that will slow silo filling. For instance, choosing a field close to the silo may not only speed filling time but also let you get by with less wagons.

Corn Silage

Fertilization – Whole plant corn silage removes much more potassium (K) than does grain harvest. Your fertility program should be adjusted accordingly. Barnyard manure makes an excellent source of K.

Hybrid selection – Use three criteria.

(1) Select a hybrid for high tonnage,
(2) Select a hybrid with high grain yield potential,
(3) Select a hybrid with high stover digestibility.

Researchers find no significant advantage to ensile specialty corns like waxy, high lysine, or high sugar corns.

Hybrids maturity – Consider planting hybrids of varying maturities if you will be filling for a long time. This will help ensure adequate moisture throughout all of your silage. It is best not to rely on a garden hose to raise the moisture of silage that's too dry.

Population – Generally plant 10% heavier than normal, but refer to a hybrids ability to handle high populations.

When to chop (recommended whole plant moisture levels) – As Figure B indicates, you will harvest the most dry matter per acre when the corn plant is at about 65% moisture. At 65% you also have a moisture level that is nearly ideal for fermentation. Chopping at higher moisture produces less dry matter because the plant is immature. And chopping drier corn produces less dry matter because of dropped ears, broken stalks, and lost leaves.

Bunkers, pits and stacks – 67-72% (whole plant moisture). You will sacrifice some dry matter yield at this level but it's worth it – you need plenty of moisture to help expel the air.

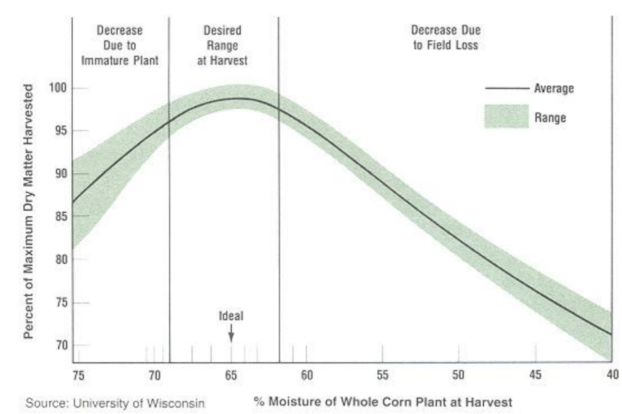


Figure B

Conventional upright silo – 63-68%. Drop one percentage point of moisture for each 10 ft. above 50 ft. silo height.

Sealed structures – 50-60%. Whole plant moisture is your most accurate moisture guide. If a silage moisture tester is unavailable the "maturity line" on the grain kernel can be a gross indicator of silage moisture. However, recent university studies have shown there can be tremendous variations in whole plant moisture in hybrids with similar milk line development. Milk line should be used as a trigger but accurate whole plant moistures need to be determined by a lab or on farm with a microwave or Koster moisture tester.

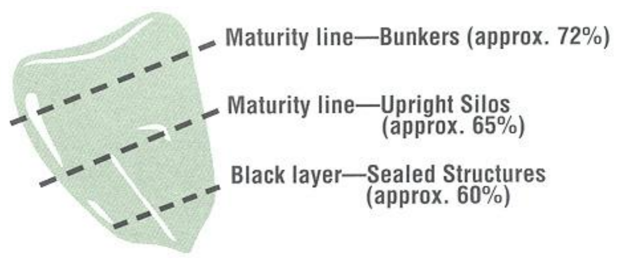


Figure C

When the maturity line has descended 1/3 of the way down to the kernel tip on healthy corn it is ready for the bunker. The silage should contain enough moisture to keep tires on the packing tractor **wet**–find a greener corn field if they become dry.

When the maturity line has descended about two-thirds of the way down to the kernel tip on healthy corn, you can begin ensiling in upright silos.

For sealed structures, ensile when the milk line has nearly descended to the tip of the kernel.

Several sources suggest to start chopping after the milk line has completely descended and "black layer" appears at the kernel tip. Our experience shows that most healthy hybrids are already around 60% plant moisture at black layer stage… and may, therefore, lack ideal moisture. Presence of black layer indicates the kernel has taken in all the nutrients it will ever take in. Chopping before black layer means nutrients that would have gone into the kernel are ensiled in the stalk portion of the plant.

Harvesting at the recommended moistures will usually give you the best of both dry matter and nutrients per acre. As the plant matures, field losses cost you dry matter and less moisture makes compaction and fermentation more difficult.

When ensiling immature corn, or corn that has been under stress during the growing season, be prepared for seepage.

Since moisture is one of the most important factors in making silage, it is important you get an accurate moisture test during ensiling. The next best alternative is to get a moisture test as you are feeding the silage, and adjust next year's practices accordingly.

Length of cut – Adjust your chopper to 3/8 - 1/2" cut. If corn gets dry, shorten to 1/4".

Processed corn silage – Silage exposed to a roller mill can generally be ensiled 4-5 points dryer and be chopped up to 3/4" and still ensile properly in storage structures. Evaluation of kernel damage is critical to determining proper processing.

Alfalfa Silage

Fertilizer – Alfalfa uses lots of potash (K_2O) Apply required K_2O after any cutting.

Variety selection – Tonnage is generally the greatest on those varieties with the most shoots from the crown of the plant. To spread harvest, you may want to plant an early variety to chop first and a medium variety to chop next.

Cut at late bud to 1/10 bloom – Although bud stage will give you a higher protein test, you will get the most protein **per acre** at 1/10 bloom. Seepage is much less likely to occur at 1/10 bloom than at the bud stage.

The effect of forage quality[1] on predicted forage dry matter intake of ruminants.

Forage Quality	Alfalfa Maturity at Harvest	% Forage NDF (dry basis)	Dry Matter Intake As % of Body Weight
Excellent	Pre Bud	38	3.16
	Bud	40	3.00
	First Flower..........	42	2.86
	Mid Flower	44	2.73
		46	2.61
		48	2.50
		50	2.40
	Mature	52	2.31
Poor		54	2.22

Adapted from data by Mertens, 1985
[1] As measured by neutral detergent fibre (NDF)

Figure D

Wilting – Fresh cut alfalfa is generally 75-80% moisture. On a good drying day you can mow in the morning and by afternoon it will be ready to chop for ensiling in an upright silo at 65%. (Aim at 50 to 60% for sealed silos.) Wilting helps prevent seepage. Wilting to 65% also provides much better "living conditions" for the right bacteria and helps control clostridia – the bacteria that cause the putrid smelling silage.

As the percent moisture decreases, harvest losses increase.

Field losses are minimal at 65%. Note how losses double at 45% (figure E). At 45% moisture you are not losing stems –

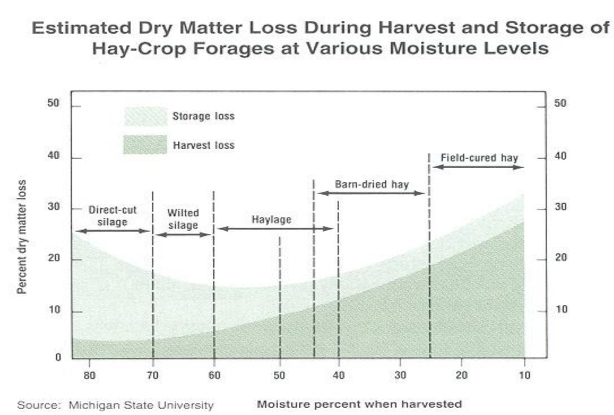


Figure E

you are losing leaves that contain 70% of the protein and 90% of the vitamins and minerals. Always try to chop before alfalfa reaches the gummy stage (about 52-55%).

It is more difficult to expel air in the silo as the forage becomes drier and heating results – which also lowers digestibility.

If some of your alfalfa windrows get too dry and baling is not an alternative, try chopping alternate windrows of wet and dry alfalfa. It is difficult to add enough water with a garden hose to raise moisture significantly.

Rain reduces the level of available carbohydrates, or energy, by increasing leaching and the amount of crude protein by leaf shattering The extent of leaching loss is Influenced by several factors, such as stage of maturity, moisture content at the time of rainfall, amount of rainfall, frequency of rains and mowing and conditioning treatments. The influence of the stage of maturity and amount of rain on dry matter losses in alfalfa and red clover is shown in Figure F.

The influence of stage of maturity and rain on dry matter losses in alfalfa and red clover as a percent of initial dry matter = % loss.

Loss	Stage of maturity	No rain	1.0 inch 1st 24 hours	1.65 inches	2.5 inches
Leaf loss	Bud	7.6	13.6	16.6	17.5
	Full bloom	6.3	9.1	16.7	19.8
Leaching & Respiration	Bud	2.0	6.6	30.1	36.9
	Full bloom	2.7	4.7	23.5	31.8
Total	Bud	9.6	20.2	46.6	54.4
	Full bloom	9.0	13.7	40.2	51.5

Source: Rohweder, 1983 ***Figure F***

Note that leaching losses increase from a low of 2 percent with no rain to nearly 37 percent after 2.5 inches of rain and that alfalfa harvested in the bud stage undergoes more extensive leaching loss than hay harvested at full bloom. This would be expected because the amount of soluble nutrients decreases in alfalfa as the plant matures.

Chopping – Adjust to 1/4 - 3/8" cut. Never chop shorter than 1/4 inch…this can reduce the digestibility of silage dry matter and crude fiber due to increased rate of passage through the animal In addition, finely chopped alfalfa has been associated with depressed milk fat tests, as well as twisted stomachs. The reduced digestibility of the chop is sometimes compensated by increased animal intake. Although animal production can then be equaled, efficiency is decreased.

Use a recutter screen only if you need to cut up those long stems that result when you can not keep the cutter head full.

Sorghum-Sudangrass Silage

Sorghum-sudangrass adapts well to low rainfall areas and growing conditions less suited to corn. Production costs are less, and sorghum-sudangrass silage has much higher crude protein, but lower TDN than corn silage when it is cut at the proper stage of maturity.

When to chop – You can begin cutting for silage when the crop has reached 30" in height. The crop should be cut prior to flowering (late boot stage). After flowering, both the TDN and crude protein will drop dramatically When cutting, leave a 6" stubble to promote rapid regrowth.

The crop should be windrowed and allowed to wilt to 67-72% moisture for bunkers, 63-68% moisture for conventional upright silos, and 50-60% moisture for sealed silos. Wilting will reduce the concentration of prussic acid.

Avoid ensiling too wet or too dry. Excessive moisture encourages seepage and the production of butyric acid which will produce a less palatable silage and reduced animal intake. Silage which is too dry may heat excessively reducing the digestibility.

Length of cut – Adjust chopper to 1/4" to 3/8" cut.

Small Grain Silage

Silage is an excellent way to utilize small grain crops used in companion cropping programs or grown to supplement forage supplies. Harvesting cereals as silage can also salvage a crop that has been hit by hail, frost, or insect damage.

Cereal silages should be harvested in the milk to soft dough stage to maximize the yield of TDN/A. As cereal grains mature from the boot to the dough stage, the protein level drops while the actual pounds of TDN/A increase. Dairy producers may want to harvest cereals in the boot stage in order to maximize protein content. Little wilting is necessary at the early dough stage.

Percent of dry matter (DM), crude protein (CP) and in vitro dry matter disappearance (IVDMD) of cereal grain forages harvested at different stages of maturity

	Hard Wheat			Soft Wheat			Barley		
Stage	DM	CP	IVDMD	DM	CP	IVDMD	DM	CP	IVDMD
Boot	18	15	64	16	15	61	16	16	63
Milk	33	11	58	30	11	58	23	11	58
Dough	48	10	56	38	9	57	40	10	61

Source: Kansas State University, Bulletin 613. ***Figure G***

Moisture levels between the range of 60-72% are best for ensiling cereal grain silage with 65% being the optimum. The moisture content can drop quickly during harvest. Avoid chopping cereals that have become over dry, because they will be difficult to pack.

FEEDING VALUES OF SMALL GRAIN AND CORN SILAGES

Silage	Dry Matter	Crude Fibre	Crude Protein	TDN
		------------(% dry matter)------------		

Barley	38.8	27.1	9.0	64.3
Wheat	39.4	27.9	9.6	63.8
Oats	40.2	31.2	9.8	60.7
Rye (wilted)	39.8	33.0	12.8	58.5
Corn	37.3	24.7	8.1	66.4

Source: Va. Tech ***Figure H***

Grass Silage

Grass as a silage crop is especially suited to areas of high rainfall where the harvesting and storage of forages is made difficult because of reduced drying weather. The production of grass silage should employ the same general management practices discussed previously. Management attention should be focused on cutting when the first stems begin to head out, wilting to less than 72% moisture chopping at 1/4"-3/8" length of cut and packing the silage well to facilitate an anaerobic environment in the storage structure.

Grass silage is often harvested in wet environments not suitable for field wilting. Ensiling direct-cut grass at high moisture levels (75-85%) presents management challenges. These high moisture ranges may allow an undesirable clostridial fermentation in the silage that produces a high level of sour-smelling butyric acid. Clostridia can also contribute to increased silage protein breakdown.

Another challenge with direct-cut grass silage is the additional lactic acid production required to lower the pH of extremely wet silage. This lactic acid is produced by bacteria feeding on plant sugars. Proper crop maturity at harvest and the presence of efficient fermenting bacteria will help reduce potential runoff problems.

If environmental conditions permit, the most ideal management practice is to wilt grass silage to approximately 63-72% moisture. This will provide an ensiling environment favorable for bacteria that can ensure proper fermentation.

High Moisture Grain

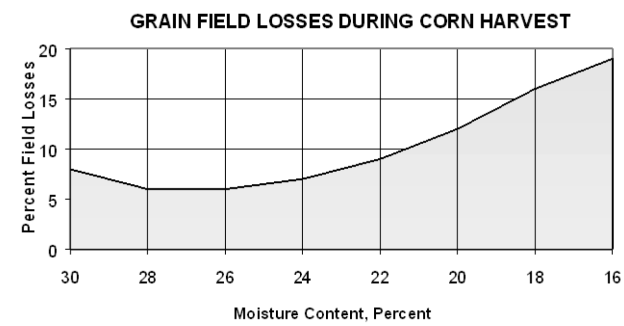
Ensiling high moisture grain is becoming increasingly popular. It allows the producer to economically store and feed grain without incurring the expense of drying. High moisture grains are easily handled, minimize field loss, and speed fall harvest.

Hybrid selection – Consider the hybrid characteristics that fit your operation and management—maturity yield, standability, rate of drydown, seeding vigor, disease, and stress tolerance. Consistency in performance should be a key consideration. Large operators should consider using several maturities to ensure adequate moistures from start to finish of harvest.

Harvest timing – Let moisture rather than calendar dates be your guide. Proper moisture minimizes field loss (Figure I), and helps in packing which reduces fermentation losses.

High moisture ear corn will contain about 5% more moisture than shelled corn (Figure J) harvested at similar maturities, due to the cob—representing about 20% of the total dry matter—which contains nearly twice the moisture content of the kernel.

The rate of drydown is influenced by weather conditions and hybrid characteristics such as tightness and length of husk cover. The kernels dry from the crown upward—not through the cob.



Source: Iowa State University ***Figure I***

% MOISTURE COMPOSITION — HMEC

Kernel	Cob	Ear
22	40	26
24	44	29
26	48	32
28	51	34
30	53	36
32	54	38

Source: University of Minnesota ***Figure J***

Begin harvest shortly after the corn has reached black layer and is fully dented. When 95% of the kernels on the ear have dented, the kernels contain about 50% moisture. When the milk line—the interface between hard starch above and liquid material below—is halfway down the kernel, the kernel moisture will be about 40% moisture. Begin harvest shortly after full dent when the hard starch layer advances to the cob and a black layer of cells at the top of the kernel appears. This indicates that the kernel has reached maximum dry weight and signals the end of kernel growth. The average kernel moisture at the black layer is 28-35%, depending upon hybrid and environmental conditions. It is important to note that hybrids may lose up to a point of moisture per day if drying conditions are optimal. Base harvest decision on workload, weather conditions, and most importantly, on the moisture and stability of each individual hybrid.

Harvest and Storage Methods – High moisture shelled corn: Grind, crack, or roll high moisture grains to improve pack and air exclusion when storing in bunker or conventional units. Most grinding is done before ensiling using a hammer mill, burr mill, or blower fitted with a recutter attachment. To minimize fines, a roller mill is preferred when processing high moisture grain stored in upright silos. The goal in any high moisture grain processing should be less than 5% fines and 5% whole kernels.

High moisture ear corn: High moisture ear corn can be harvested by using a combine modified to save a portion of the cob, or using a forage harvester equipped with a snapper head. Using a recutter screen on the forage harvester that ranges from 1/2"-1" will ensure cobs are broken to prevent separation during handling and sorting by cattle. This system will allow some non-ear plant parts (trash) to be harvested, and may reduce the feeding value and make packing more difficult than picked or combined high moisture ear corn that is processed at the silo using a tub grinder or stationary hammer mill.

In any high moisture grain system, distribution in the silo is important to minimize separation and prevent air pockets. Avoid delays. Fill silo quickly and do not allow loads of wet grain to sit for prolonged periods to "heat" prior to ensiling. Seal the storage structure with plastic to help optimize fermentation conditions.

Feed Out – Make certain enough high moisture grain is removed each day. Sizing storage structures such that a minimum of 2" is fed out in winter and 4" in summer will help reduce heating problems and ensure fresh feed.

Stressed Crops

Unfavorable weather conditions require special consideration for silage management. Yields of frost and drought damaged crops are usually maximized when harvested as silage. The same holds true for crops that are immature due to late planting or poor growing conditions.

Frost – Frost damaged **corn** for silage may be classified two ways for management purposes. First, if the killing frost occures **before** the plant is physiologically mature the plant will appear drier than unfrosted corn of the same moisture content. Although the leaves dry rapidly after a few sunny days, the green stalk and ears do not…so be sure the moisture of the whole plant is not greater than the optimum range of 63-68%. Second, if the killing frost occurs **after** the plant has reached maturity (black layer), the moisture content will fall rapidly. Consider a finer chop (1/4 inch) and adding water if you cannot ensile the corn before the moisture drops below 60%. Although yield per acre is reduced, high quality can still be maintained in frost damaged corn.

Alfalfa is more likely to cause bloat if it is grazed or fed as greenchop immediately after a frost. However, alfalfa which is mowed, wilted, and stored as silage seldom causes bloat.

Frost damaged **forage sorghum** should be managed in a similar manner to frost damaged corn. Determine the stage of plant maturity when frost occurs and then manage accordingly. Frost damaged, mature forage sorghum will dry very rapidly. (See prussic acid.)

Drought – A drought will usually result in a choice between two management options, depending upon severity. If the plant is not going to recover following a long drought, plan to ensile it soon. Delay will not improve quality and yield per acre will decline. A shorter, less severe drought will usually result in the plant being immature when the killing frost does occur.

Again, the plant will appear to be drier than it actually is…so be sure the moisture does not exceed the optimum range (63-68%). (See nitrates.)

Although yields of drought damaged corn can be quite low, the feeding value of the silage is 75-90% of normal corn silage. It is best to get drought silage analyzed to make the most of your feeding program.

Nitrates (NO^3) – You have the potential for a high nitrate situation when stress (drought, hail, frost, cloudy weather, fertility imbalance) cuts the crop yield to less than the nitrogen fertility level you have supplied.

Nitrates accumulate in the lower portion of the stalk during stress periods (drought, hail, or frost). If the plant recovers, the nitrate will be converted to a non-toxic form which is then deposited in the plant tissue.

Try to leave a 12" stubble when chopping "stress" silage. And if you encounter rain, wait three days before resuming chopping.

If many plants have not developed ears, get a nitrate test before feeding any green chop. If the test shows a nitrate problem, then the chopped corn should be diluted 50% with other feed. The nitrate level of the green chop would be cut approximately in half if it was ensiled.

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The bacteria in the animal rumen must adjust to high nitrate rations; so start them on such feed **gradually**. Once adjusted the animals do very well on such feed. Supplementing "high-nitrate" silage with plant-source protein rather than urea is generally preferred.

Prussic Acid – Prussic acid accumulates in forage sorghum and sorghum-sudangrass that first undergoes stress and then has a rapid regrowth. Poisoning occurs when animals graze young sorghum plants, drought-stunted plants, or damaged or stressed plants. Sorghum plants are poisonous after a frost kills the tops but not the crown, or when new growth is brought on by a rain following a drought. If new shoots develop after a light frost, do not graze until a killing frost occurs.

Minimum plant growth for safe grazing, green chopping, or silage making is 30" for sorghum-sudangrass. Forage sorghums should be headed out for ensiling. If hit by frost at these stages, wait 3 days before grazing or ensiling. If the plants are frosted before these maturity stages, then wait two weeks before ensiling.

Although the ensiling process does not decrease the prussic acid level in sorghum-sudangrass silage, it may be safer to feed because much of the poison escapes as a gas when the silage is removed from the silo for feeding. Do not feed new silage for 3 weeks after ensiling. Field curing or drying will release 50-70% of the prussic acid.

Other Observations

- A high N/low P soil fertility increases the risk of both high nitrates and prussic acid.
- Let drought or stress silage ferment a full 3 weeks before feeding.
- Silo gas is most likely to occur in high nitrate silage, but you should always be wary of it. Silo gas can be yellowish, reddish or colorless. Since silo gas is heavier than air, run the blower for 15 minutes if you must enter the suspected silo. If you are exposed to silo gas, see a doctor immediately. Always think safety.
- If it is not possible to test your silage for nitrates or prussic acid, "test feed" the suspected silage to a couple of less valuable animals. Start cattle on the silage gradually.

Procedures for Forage Testing

Before it is possible to obtain a usable analysis of individual lots of hay or silage, a **representative** sample of the feed must be obtained for the laboratory. The key word is **representative**. If the lot is 40 tons of first cutting of alfalfa and a one-half lb. sample is sent to the laboratory, the sample is 1/160,000th of the available hay! Likewise, if the lot is 1,000 tons of silage and a one-half lb. sample is sent, the sample is 1 part in 1 million from the silo! Obviously, it is impossible to take a few hands full of forage and have a useful sample. Dairy producers who have learned the value of managing "little-things" do the type of sampling needed to get accurate and representative samples to work with.

Dairy specialists at Cornell University (Chase and Sniffen, 1988) make the following suggestions for proper sampling.

Sampling baled hay. The only way to sample baled hay is with a bale borer. Steps to follow are:

1. Sample a minimum of 10 bales from each lot of hay and a large sample is preferred.
2. Bore only into the ends of the bales.
3. The hay cores should be placed in a plastic pail and mixed thoroughly.
4. Place the sample in a plastic bag for sending to the laboratory.

Sampling silage. There are two suggested methods.

1. Sampling during silo filling (first choice).
   a. Take grab samples from each load of forage.
   b. Collect the samples in a large plastic bag or container.
   c. Make notes of where the samples were taken in the silo.
   d. Use colored plastic strips to mark areas in the silo represented by each sample.
   e. Thoroughly mix the samples, subsample, freeze, and send to the laboratory.
2. Sample during silage feeding (second choice).
   a. In upright silos fill a silage cart and take small samples from several locations. Do not sample directly from the silage surface.
   b. In bunker and trench silos rake the entire exposed surface with a front end unloader. Take grab samples from the surface or from a mixer wagon that has blended the silage for a few minutes. If it is not possible to rake the surface, dig back 3 to 6 inches behind the exposed surface to obtain 10 to 20 grab samples.

ESTIMATED WAGON CAPACITIES

Depth (feet)	70% Moisture Wagon Length				Depth (feet)	60% Moisture Wagon Length			
	20'	18'	16'	14'		20'	18'	16'	14'
1	2.0	1.5	1.5	1.5	**1**	1.5	1.5	1.0	1.0
2	4.0	3.5	3.0	2.5	**2**	3.0	2.5	2.5	2.0
3	5.5	5.0	4.5	4.0	**3**	4.5	4.0	3.5	3.0
4	7.5	7.0	6.0	5.5	**4**	6.0	5.5	5.0	4.0
5	9.5	8.3	7.5	6.5	**5**	7.5	7.0	6.0	5.5
6	11.5	10.0	9.0	8.0	**6**	9.0	8.0	7.0	6.5
7	13.0	12.0	10.5	9.0	**7**	10.5	9.5	8.5	7.5
8	15.0	13.5	12.0	10.5	**8**	12.0	11.0	9.5	8.5
9	17.0	15.0	13.5	12.0	**9**	13.5	12.0	11.0	9.5
10	19.0	17.0	15.0	13.0	**10**	15.0	13.5	12.0	10.0

CONCRETE SILO CAPACITIES

Diameter and Settled depth	Alfalfa Silage (Tons)				Corn Silage (Tons)				Ground Ear Corn (Tons)		
	Moisture Content				Moisture Content				Moisture Content		
	40%	50%	60%	70%	40%	50%	60%	70%	30%	35%	40%
12 x 30	35	44	57	83	47	54	62	74	73	83	95
12 x 40	50	62	80	116	66	75	87	103	98	112	130
12 x 50	63	78	104	150	85	97	111	132	125	142	165
14 x 40	69	86	114	163	93	106	121	143	136	155	177
14 x 50	89	111	148	210	121	137	158	185	171	197	230
14 x 55	99	125	164	240	134	153	175	210	190	220	250
16 x 50	120	151	200	290	163	184	210	250	230	260	300
16 x 60	149	186	250	360	200	230	260	300	270	320	370
16 x 65	162	200	270	390	220	250	280	330	300	350	400
18 x 50	157	196	260	370	210	240	270	320	290	330	390
18 x 60	194	240	320	460	260	290	340	390	350	410	470
18 x 70	230	290	390	560	310	350	400	460	410	480	560
20 x 60	250	310	410	590	330	370	420	490	440	510	590
20 x 70	300	370	490	700	390	440	500	580	510	600	700
20 x 80	350	430	580	820	460	510	580	670	590	690	800
24 x 60	370	470	620	880	490	540	620	710	640	740	860
24 x 70	450	560	740	1,050	580	650	740	850	750	870	1,020
24 x 80	530	660	870	1,230	680	760	850	980	860	1,000	1.170
24 x 90	610	760	1,000	1.410	780	860	970	1,110	980	1,140	1,330
30 x 80	880	1,090	1,430	2,000	1,090	1,280	1,480	1,630	1,370	1,590	1,850
30 x 90	1,010	1,260	1,650	2,290	1,240	1,480	1,710	1,880	1,550	1,800	2,100

STEEL SILO CAPACITIES

Diameter and Settled depth	Alfalfa Silage (Tons)				Whole Shelled Corn (Tons)		
	Moisture Content				Moisture Content		
	40%	50%	60%	70%	25%	30%	35%
12 x 30	37	47	62	89	84	92	101
12 x 40	54	67	88	127	112	124	136
12 x 50	69	87	116	166	142	156	173
14 x 40	75	94	123	177	156	170	187
14 x 50	98	123	163	230	195	220	240
14 x 55	110	138	183	260	220	240	260
16 x 50	132	165	220	310	260	280	310
16 x 60	165	210	270	390	310	340	380
16 x 65	183	230	300	430	340	370	410
18 x 50	171	210	280	400	330	360	400
18 x 60	210	270	350	500	400	440	480
18 x 70	260	330	430	610	470	510	570
20 x 60	270	340	450	630	490	540	600
20 x 70	330	410	540	760	580	640	700
20 x 80	390	490	630	890	660	730	810
24 x 60	410	510	660	930	720	790	880
24 x 70	490	620	800	1,120	840	930	1,020
24 x 80	590	730	940	1,310	970	1,070	1,180
24 x 90	680	840	1,090	1,500	1,090	1,200	1,330
30 x 80	960	1,180	1,520	2,090	1,530	1,680	1,860
30 x 90	1,110	1,370	1,750	2,390	1,730	1,900	2,100

Source: J. C. Joliet, University of Guelph, Guelph, Ontario. Adapted from the October 25, 1986 issues of Hoard's Dairyman, Copyright 1986 by W. D. Hoard and Sons Company, Fort Atkinson, Wisconsin.

HORIZONTAL SILO CAPACITIES

Depth (feet)	Bottom width, feet*						
	20	30	40	50	60	70	80
	(Tons** per foot of length)						
8	3.4	5.0	6.5	8.1	10.0	11.3	13.0
10	4.3	6.2	8.4	10.2	12.2	14.2	16.2
12	5.2	7.5	10.0	12.3	14.6	17.0	20.0
14	6.0	8.7	11.5	14.3	17.0	20.0	22.7
16	7.0	10.0	13.1	16.3	20.0	22.7	26.0
18	8.2	11.1	14.7	18.3	22.0	27.6	29.1

* Sidewalls slope out 1' in 8' of height.
** Capacity based on 40 lbs. per cubic foot. (Approximately 70% moisture silage).

Source: Silage and Silos. Special circular #223. The Pennsylvania State University College of Agriculture, Extension Service, University Park, Pennsylvania.

APPROXIMATE SILO BAG CAPACITIES

Bag Size	Corn Silage (wet tons)	Haylage (wet tons)	High Moisture Shelled Corn (bushels)	Ground Ear Corn (bushels)	Ground Shelled Corn (bushels)
8' x 100'	95	85	2600	2000	3100
8' x 150'	145	130	4100	3200	5000
8' x 200'	195	175	5735	4300	6800
9' x 135'	145	130	4300	3500	5500
9' x 150'	175	160	4800	3900	6100
9' x 200'	230	200	6600	5300	8400

Source: John Chastain, Ext. Ag Engineer - U of MN - 1993
** Actual capacity varies with moisture content, length of cut and ensiling tension.*