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Corn Silage

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Corn silage is a popular forage for ruminant animals because it is high in energy and digestibility and is easily adapted to mechanization from the stand-crop to time of feeding.

Corn silage should have a light, pleasant smell with only a slight vinegar odor. It should be slightly brown to dark green. If it is dark brown or has an odor that is fruity, yeasty, burnt or rancid (butyric acid), excessive heating or improper fermentation has occurred. Knowledge of the silage process often explains why some silage may be of poor quality.

Ensiling process

Chopped forage is compressed as it is ensiled. The cells of the corn plant are still alive and breathing. This breathing by plant cells and microorganisms forms carbon dioxide and heat by using the trapped air. As carbon dioxide increases, an anaerobic condition is formed in the silo. Desirable bacteria start the fermentation process when plant respiration stops.

If too much air is present or if carbon dioxide escapes, respiration will continue and the plant cells will use too much sugar and carbohydrates. This wastes nutrients needed by the desirable bacteria to "pickle" or preserve the green material as silage. This is why packing and covering immediately after filling is important.

Seepage takes place if moisture in the forage is excessively high. This usually reaches its peak on about the fourth day after ensiling. Ideally, moisture content of the forages going into the silo should be sufficiently low to prevent seepage loss. On the other hand, silage that is too dry may not pack adequately and a higher loss from fermentation and molds will occur.

Once respiration by the plant cells ceases, acetic and lactic acids are produced by bacteria that feed on the available starches and simple sugars in this chopped corn. For desirable bacteria, the silage needs the exclusion of air, temperatures between 80 degrees and 100 degrees Fahrenheit and starches and sugars for food.

Fermentation will continue until enough acid is produced to stop bacterial action. The desired degree of acidity, a pH of about 4.2, should occur within 3 weeks after the silo is filled.

Three different kinds of silage may be recognized according to the temperature during fermentation:

Underheated silage is drab green in color and has a strong odor, slimy soft tissues and a pH of 5 or above.

Overheated silage ranges from brown to black and usually has a caramel odor of slightly burned sugar.

Properly heated silage is light green to yellow in color and has a vinegar type odor, firm plant tissues and a pH below 4.5.

If improper packing permits too much air to be trapped in the silage mass, or if air seeps into the material, or if too much moisture is present, insufficient acid will permit undesirable bacteria to produce butyric acid. These bacteria consume carbohydrates, protein and lactic acid as they multiply. Formation of butyric acid will raise the pH and fermentation continues until all the readily available energy is exhausted. That is why the smell of rancid butter (butyric acid) indicates poor-quality silage that is low in energy.

Hybrids

A corn hybrid that is a high grain yielder usually will be a top silage producer. A variety that matures slightly later than one harvested for grain is often the most satisfactory for silage. Both hybrids will dent about the same time, but the later-maturing varieties lose moisture more slowly than the earlier-maturing varieties. This allows a somewhat longer period for silo filling.

Hybrid varieties sold for their high sugar content (earless) may tend to have slightly higher protein content but are higher in fiber and lower in energy than those varieties which give high yields of grain. Many special silage varieties are simply tall growing, long season hybrids and may not yield as much nutrients as a top grain yielding hybrid.

Planting date

Early planting of corn for silage is one of the best ways to increase grain content. It will give higher grain yields and somewhat lower stalk heights. The total dry matter produced will vary little between corn planted from late April to late May, but the grain content may vary considerably.

Plant population

Corn to be used for silage may be planted at a rate of 2,000 to 3,000 more stalks per acre than corn to be harvested for grain. In most of Missouri a population of 18,000 to 24,000 plants per acre is ideal for silage.

Corn planted at extremely high seeding rates of 30,000 to 50,000 stalks per acre will have less energy per acre than when planted at the recommended rates. Seeding rates that are too high push yields down, not up.

Row spacing

Silage yields increase with narrow rows at about the same rate as grain yield increases. The increase can be up to 10 percent. Costs in changing silage harvesting equipment should be the main consideration in deciding whether to go to narrow row silage.

Fertilizer

A 100-bushel corn crop harvested as silage removes more than twice as much nitrogen, three times as much phosphorus and 10 times as much potassium as when the crop is harvested for grain. The removal of the stalks accounts for the extra nutrient removed from the land. A 20-ton silage crop will remove approximately 175 pounds of nitrogen, 35 pounds of phosphorus and 175 pounds of potassium.

If corn silage is removed from the same fields for consecutive years, additional application of fertilizer, especially potash, will be necessary. On land used for producing corn silage, it is best to apply 100 to 150 pounds of nitrogen per acre plus other nutrients according to soil test requirements.

Insecticide residue

It is highly important that dairy and beef cattle producers be informed about the insecticide applied to corn that is harvested for silage. Use only those materials that are properly cleared. Check with a MU Extension center if in doubt about a particular compound.

Grain content of silage

Contrary to popular belief, the ratio of bushels of grain per ton of silage is not a constant factor. Grain yields increase much more rapidly than do total forage yields. Ratio of grain per ton of silage fluctuates widely and this is an important consideration in estimating silage feeding values or costs of corn silage. Each case should be determined on its own merits as general rules are not consistent.

Table 1
Example of how bushels of grain per ton of silage may vary at different yield levels

Grain per acre	Grain per ton of silage
89 bushels	5.0 bushels
117 bushels	6.0 bushels
124 bushels	6.2 bushels
131 bushels	6.9 bushels
152 bushels	7.5 bushels
160 bushels	8.1 bushels
180 bushels	12.0 bushels

***These values are not a guide as to grain - silage ratios, but are shown as examples of the wide variation involved**

Harvesting

Corn should be harvested for silage after the ear is well dented but before the leaves turn brown and dry. The quantity and quality of corn silage are at their peak in this stage of development. The ear has accumulated most of its potential feeding value, but there has been little loss from the leaves and stalks. After the dent stage, feeding value of corn stalks and leaves decreases while field losses increase.

Fall temperatures influence the maturity rate of the grain. Maturity usually refers to the time when the ear has accumulated 100 percent of its dry matter production potential. In many years this potential is not achieved because of cool temperatures and cloudy weather. Values listed in Table 2 may be used as a guide to determine when maximum dry matter production has occurred, but variety and weather interactions will exhibit some influence on the result. Ears usually will be well dented somewhere between the 32- to 35-percent moisture stage.

Table 2
Relationship of kernel moisture to yield potential

Water in kernels	Yield of grain as percent of maximum
40 percent	93.5
38 percent	94.8
36 percent	96.3
34 percent	98.0
26 percent	100.0
21 percent	98.0

Corn harvested for silage in the milk or dough stage will yield less feed nutrients per acre than if harvested later. Corn also may ferment improperly in the silo if harvested too soon. Corn silage often is made too early because it is believed that feed is lost if undigested corn kernels appear in the manure. This is not true. Digestibility is as high for well-dented kernels as for immature corn grain.

Corn silage that is cut late and has brown and dead leaves and stalks usually will make fair- to good-quality silage, but total production per acre may be sharply reduced. Field losses as high as 30 percent have been found when silage is made late into the fall or early winter. A 10 percent reduction in the amount of dry matter stored in the silo also has been noted with late-cut silage.

Results of feeding trials with late-cut silage tend to vary, but in most cases the quality of late-cut corn silage has been slightly lower than silage made from corn cut soon after the dent stage of the ear.

Present research does not support recommending late-cut or mature corn silage as a standard farm practice (Table 3). However, it does indicate that in emergency conditions, corn may be harvested over a wide period of time and still make a satisfactory feed.

Table 3
Influence of time of harvest on field losses

Harvest Date	DM Yield	Silage 33 percent DM
l964 Normal (Sept. 21)[1] 1964 Late (Nov. 9)	5,330 4,300	8.0 (T) 6.5 (T)
1965 Normal (Sept. 8)[1] 1965 Late (Nov. 8)	9,918 7,230	14.8 (T) 10.8 (T)
1966 Normal (Sept. 13)[2] 1966 Late (Oct. 17) 1966 Late (Nov. 14)	10,220 9,140 8,120	15.3 (T) 13.7 (T) 12.1 (T)

[1]Gordan, et al., Beltsville, Md.
[2]Geasler and Henderson, Michigan State

Damaged corn for silage

Corn that has been damaged by drought, high temperatures, blight, frost or hail can be salvaged for silage. Quality will not be as high as where corn has reached the dent stage. Feeding value will depend upon the state of development and how it is handled after the damage occurred. Silage from immature corn usually is higher in moisture, does not ferment in the same manner, frequently has a sour odor and is more laxative when fed in

large quantities.

Frosted corn has a low carotene content and should be cut as soon as possible. It will dry out quickly and lose leaves. It may be necessary to add water to corn that has frosted and become too dry to pack well. Drought corn also may need added water. When the corn forage is dry, keep the chopper knives sharp and chop as fine as possible.

Immature corn that has been damaged by extremely high temperatures should not be immediately ensiled. Although these plants may never produce an ear, some additional stalk growth and consequently some additional feed may be produced by delaying harvest. If the plants are harvested for silage soon after they have been extensively damaged by heat, the stalk will have so much moisture that a very low quality silage will result. Nutrients also will decline significantly through seepage.

Corn that has been damaged by leaf diseases such as the southern corn leaf blight often are made into silage. The blight organism is not believed to be toxic to ruminants. It also has been shown that it does not survive the ensiling process. In severe cases, a secondary infection of molds on the damaged areas of the plant may produce a harmful toxin. However, limited research indicates that this is unlikely.

The greatest problem with this type of silage stems from its lack of energy due to reduced grain formation and improper fermentation due to the excessive dryness of the damaged plant. In severe cases where large areas of the corn plant are dead, fermentation problems caused by the lack of plant moisture could arise.

Nitrates

Under certain soil and environmental conditions, the corn plant may store an excessive amount of nitrogen compounds.

Nitrate poisoning and drought conditions often are associated, but the condition is difficult to define. The degree of drought and nitrogen availability generally confuses the issue. As the soil moisture level becomes acute, nitrates move toward the soil surface above the corn roots. Some drought-stricken corn may be short of nitrate instead of oversupplied.

If heavy rains occur at this point, excess nitrogen is leached downward and may be taken up by the corn root system. This could cause abnormally high nitrate levels in the plant. Under these conditions, avoid harvesting silage from the stricken fields for a few days.

One measure that may be helpful in reducing the amount of nitrate in the silage is, to allow the corn plant to grow beyond the period of drought damage. If the plant is capable of making some regrowth following a drought, it may be able to use much of its excessive stores of nitrogen for additional regrowth.

The highest concentrations of excessive nitrogen usually are in the lower portion of the stalk. Raising the chopper cutter blade so that the lower 18 or 20 inches of the stalk remain in the field also may reduce the concentration in the silage. Testing for nitrates before silage harvest is frequently unreliable as a feeding guide. Nitrate level in the plant changes rapidly from day to day and usually is reduced about 1/3 in the ensiling process.

If silage is suspected to contain excessive nitrates, it can be detected by test prior to feeding. This analysis should be taken as near to the time when the silage will be fed as practical.

Silo gases

Lethal gases may occur at any time during silo filling. The greatest danger is 12 to 72 hours after filling, but gas may occur up to 10 days after the last silage is put in the silo.

Silo gases may appear in any ensiled material, grown on any type of soil and under any level of fertilization.

If the gases are present in higher concentrations, two of them, nitrogen dioxide (NO_2) and nitrogen tetroxide (N_2O_4) may be recognized by their irritating odor and color. Nitrogen dioxide is reddish brown and nitrogen tetroxide is yellow. Nitric oxide (NO) is a colorless gas that may be present in deadly concentrations without being visible.

The gases are heavier than air and remain beneath the air mass over the silage. They often will layer on top of the silage just below the upper edge of the top door. They may settle down the chute to accumulate at the bottom of the silo, in unloading chutes, in adjacent feed rooms and may even move into the barn, loading areas or milk houses. They usually leave a yellow stain on silage, wood or other materials they contact. The presence of dead birds and small animals around these areas is one indication that the gases are at dangerous levels.

A few simple rules will prevent tragedy and injury:

- Run the blower 15 to 20 minutes before going into a partly filled silo. Keep the blower running while anyone is inside.
- Stay out of the silo for at least a week or preferably two after the silo is filled.
- If you experience the slightest throat irritation or coughing, get into fresh air quickly. Immediate treatment by a doctor is an absolute must.
- Ventilate the silo room for at least two weeks after filling by opening outside doors and windows to carry away fumes. Removing the chute doors on the silo down to the level of the settled silage will permit natural ventilation where gas tends to be concentrated.
- Keep the doors between the silo room and the barn closed to protect livestock.

Length of cut

Corn silage should be cut into particles 1/2 to 3/4 inches in length. Particles of this size will pack more firmly in the silo and are more palatable to cattle. Very finely cut silage may be made with a recutter. This will increase the amount of dry matter that can be stored in a silo, but very finely cut silage is less palatable and has resulted in lower butterfat tests when this feed was the primary source of roughage for dairy cattle.

Adding water to dry silage

If silage is too dry, it may be necessary to add water in order to establish airtight conditions. As a rule of thumb, add four gallons of water per ton of silage for each 1 percent desired rise in moisture content. Add this water as the silo is being filled. If water is added after the silo is filled, it tends to seep down the silo walls and does not permeate the silage mass. This may cause leaching of silage nutrients, seepage that may break the air seal and improper fermentation.

Frozen silage

Frozen silage is sometimes a problem, especially with trench or bunker silos. Freezing does not impair the keeping quality of silage so long as the silage is not disturbed, but frozen silage may cause digestive disturbances when eaten by cattle. It is best to thaw silage before feeding it.

Silage additives

Top quality silage can be made without the addition of any additives or preservatives. There is no reliable evidence that adding enzymes, yeast cultures, antibiotics or acid-forming bacteria will increase the feeding value of corn silage. The two additives most often used in corn silage are limestone and non-protein nitrogen compounds.

Molasses and grain may be added to corn forage at the time of ensiling. However, this practice only tends to enrich the resulting corn silage as a feed rather than to improve the quality of the corn forage itself. There is also some fermentation loss with the added molasses and grains.

Molds

Molds are common in silage, especially around silo doors and edges of bunker silos. White and gray molds, which are caused by exposing silage to air, are seldom toxic to livestock, but intake is sometimes reduced. A mold known as *monascus* causes silage to form lumps or small clumps, which are white on the outside but have a reddish center. Cattle usually will eat silage containing this mold. There have been no reported cases of toxicity.

In the spring as warm temperatures occur, a rapid-forming red mold may appear on the face of the silage between morning and evening feedings. This is commonly known as bakery mold, *monilla sitophilia.* The mold spores are activated by the heat produced in the silage process and grow quickly when exposed to air. It has not produced any known cases of toxicity.

Silo capacities and filling

Tables giving estimated silo capacities often vary due to the crop ensiled, length of cut and effectiveness of distribution and packing at filling time. Most tables are based on silage harvested at 30 to 35 percent dry matter.

Silo capacities actually vary little in terms of dry matter storage, despite differences in moisture content at filling time. An exception to this is material that is 50 percent dry matter or more at the time it is placed in the silo. With this type of material, dry matter capacity may be reduced as much as 10 percent for estimates based on 30 to 35 percent dry matter.

With large-capacity silos and high-speed filling methods, the distribution and packing of silage in silos has been sacrificed. Improper distribution and packing may cause excessive seepage, poor fermentation and losses in storage capacity. Half the capacity of the silo, which is 14 feet in diameter, is in the outside 2 feet. If an overabundance of fluffy, light material is in this outside area, silo capacity may be reduced as much as 20 percent. Most large tower silos should be equipped with a distributor to aid in proper silage distribution and packing. Length of cut of corn should be 1/2 to 3/4 inches to ensure proper placing.

Covering filled silos

A loss of nutrients occurs in all silage during the ensiling process. Microorganisms that carry out the fermentation process require energy. This loss depends on the effort made to exclude air at time of filling and to prevent loss of carbon dioxide, which is necessary to arrest respiration of the ensiled plant cells, as well as prevent seepage losses and undesirable fermentation or spoilage due to surface exposure. There is probably a greater range of losses within a particular type or design of silo than occurs in different types of silos where

equally good ensiling practices are followed. So, regardless of silo structure, good ensiling practices save feed.

A plastic cover on a trench or bunker silo or a large-diameter tower silo can materially cut feed losses. For best results, the cover must be applied immediately after the last load is packed in the silo.

On trench or bunker silos, it is important to mound or crown the forage so that the rain water will drain off the silo. Plastic covers that are not weighted to hold them firmly on the surface of the silage will be only partly effective. Covering the plastic with old tires plus limestone, sawdust or similar material can be of great benefit.

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Related MU Extension publications

- G2061, Corn Silage for Beef Cattle
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=G2061
- G3150, Forages for Cattle: New Methods of Determining Energy Content and Evaluating Heat Damage
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=G3150
- G4591, Estimating Silage Value to the Crop Producer
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