COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY—COLLEGE OF AGRICULTURE

Producing Corn for Silage

Chad D. Lee, James H. Herbek, Garry Lacefield, and Ray Smith, Department of Plant and Soil Sciences

Corn for silage has been a valuable source of feed for cattle. High-quality corn silage is obtained with a combination of good crop management practices, good silage management practices, and optimum weather conditions. This publication will focus on the management practices of growing corn for silage.

Crop Management Practices

Hybrid Selection

Selecting hybrids is an important decision in silage production. Capitalizing on high-yielding hybrids will allow you to raise more silage per acre.

Each year, hybrids for grain are evaluated at seven locations across the state in the University of Kentucky Hybrid Corn Performance Test. The hybrid performance test provides an annual report and ranks yields from each location, averaged over all locations and averaged across one, two, and three years. Land grant universities in neighboring states conduct similar tests. All of these tests are linked to the Grain Crops Variety Testing page at <http://www.uky.edu/Ag/GrainCrops/varietytesting.htm>. County Extension agents and seed companies also conduct hybrid comparisons, and these tests are an excellent way to evaluate hybrids in your area. Examining hybrid tests conducted across the state provides a stronger comparison for how a hybrid will perform in multiple environments and conditions. In general, hybrids that produce good grain yields also produce good silage yields.

Hybrid Maturity. Corn requires a combination of nutrients, water, light, and heat to germinate and to reach maturity. Corn maturity is commonly referred to as "days." Corn grown for silage is often in the 113 to 120 days maturity range in Kentucky. Depending on acreage and harvesting requirements, selecting hybrids across this range in maturity can help with harvest schedules. Not only does selecting a range in maturity help spread out harvesting, but it can help spread out the workload for postemergence weed control and the risks associated with pollination.

The growth and maturity of a corn hybrid are closely related to daily and seasonal temperature levels. A more accurate scheme for labeling corn hybrid maturity is the growing degree day (GDD) method. The GGD method predicts corn maturities based on mean daily temperatures during the growing season. By knowing the GDD requirement for each hybrid, that hybrid will have a reasonable chance of maturing before frost. A full-season hybrid in Kentucky has an average GDD of 2,650 to 2,700. Table 1 illustrates the GDD requirements for a corn hybrid with a 2,700 GDD maturity.

Corn needs to capture as much light as possible during the reproductive stages of development to maximize yield. Hybrid maturity, planting date, seeding rate, row spacing, adequate nutrients, adequate water, and lack of pest competition all affect canopy development.

Growing degree days accumulate much more rapidly for corn grown late in the season compared with corn grown early in the season. Regardless of when a 2,700 GDD corn is planted, it requires 2,700 GDD to reach maturity. However, when a 118-day corn (2,700 GDD) is planted early, it may require 120 days to reach maturity. If that same hybrid is planted late, it may require 110 days to reach maturity. For example, in Table 2, if a 2,700 GDD hybrid is planted on April 15, it will mature on Aug. 18, or 126 days. However, that same hybrid planted on May 15 in Mayfield, Kentucky, will mature on Sept. 4, or 113 days.

Hybrid Types for Silage. A dual-purpose hybrid is one that is grown both for grain and for silage. These dual-purpose hybrids are compared in the University of Kentucky Corn Hybrid Performance Test. Specialty hybrid types include waxy, nutridense, leafy, and brown midrib types. Waxy hybrids have a higher concentration of more-easily digested long chain starches. Nutridense hybrids have about 2 percent more protein and starch in the kernel than dual-purpose hybrids. Leafy hybrids have more leaf production above the ear than dual-purpose hybrids. Brown midrib hybrids have less lignin concentration than dual-purpose hybrids, making brown midrib forage more digestible. While each of these hybrids have special traits that are intended to improve overall feed value, none of these hybrids should be left in the field for grain. In addition, very few of these traits are in corn maturities later than 112 days, making these hybrids short in maturity for Kentucky.

Herbicide Resistant Hybrids. Herbicide resistance traits are available in several hybrids. These traits include glyphosate-resistance (Roundup Ready), glufosinate-resistance (Liberty Link), and imidazolinone-resistance (Clearfield Corn). Corn possessing either glyphosate resistance or glufosinate resistance was genetically engineered. While these traits may provide an option that a producer wishes to use, these traits alone do not guarantee a high-yielding hybrid. As with any hybrid, be sure to select a hybrid that yields well.

Insect Resistant Hybrids. The two major traits for insect resistance are corn borer and corn rootworm. Both of these traits were accomplished in corn with genetic engineering. Hybrids with resistance to corn borers are recommended in Kentucky for late planting dates that favor infestation of the corn borers. So far, hybrids with resistance to rootworm have not yielded as well as other hybrids in the hybrid performance test in Kentucky or in other states. Until hybrids with rootworm resistance yield above average in the University of Kentucky hybrid performance tests, the rootworm-resistant hybrids will not be recommended for Kentucky. These traits only help the corn plant to resist a certain insect or insects. These traits do not guarantee a high-yielding hybrid. When selecting hybrids with one of these traits, be sure to select a hybrid that yields well.

Disease Tolerant Hybrids. Many corn hybrids have partial tolerance to certain diseases and viruses. Gray leaf spot, northern leaf blight, and southern leaf blight are all diseases that are of

Table 1. Growing degree days (GDD) needed for different stages of development for a 2,700 GDD hybrid. [1]

Growth Stage	Development Stage	GDD
V2	Two leaves fully emerged (two collars visible)	200
V4	Four leaves fully emerged	345
V6	Six leaves fully emerged (growing point above ground)	475
V8	Eight leaves fully emerged (tassel beginning to develop)	610
V10	Ten leaves fully emerged	740
V16	Sixteen leaves fully emerged (tip of tassel emerging)	1,135
R1	Silks emerging, pollen shedding	1,400
R2	Kernels in blister stage	1,660
R4	Kernels in dough stage	1,925
R5	Kernels in dent stage	2,190
R6	Black layer has formed (physiological maturity)	2,700

[1] GDD requirements are from the National Corn Handbook.

Table 2. Expected date for black layer formation based on location, planting date, and hybrid maturity (growing degree days).

		Different Hybrid Maturities (GDD)		
Kentucky Location	Planting Date	2,400	2,700	3,000
		Date to Reach Black Layer[1]		
Mayfield	15-Mar	28-Jul	8-Aug	20-Aug
	1-Apr	1-Aug	13-Aug	24-Aug
	15-Apr	6-Aug	18-Aug	30-Aug
	1-May	14-Aug	26-Aug	8-Sep
	15-May	23-Aug	4-Sep	19-Sep
	1-Jun	5-Sep	20-Sep	11-Oct
Bowling Green	15-Mar	27-Jul	7-Aug	19-Aug
	1-Apr	31-Jul	12-Aug	23-Aug
	15-Apr	5-Aug	17-Aug	29-Aug
	1-May	12-Aug	24-Aug	5-Sep
	15-May	21-Aug	2-Sep	16-Sep
	1-Jun	3-Sep	18-Sep	7-Oct
Henderson	15-Mar	27-Jul	8-Aug	20-Aug
	1-Apr	1-Aug	13-Aug	24-Aug
	15-Apr	6-Aug	18-Aug	30-Aug
	1-May	14-Aug	25-Aug	7-Sep
	15-May	23-Aug	4-Sep	19-Sep
	1-Jun	5-Sep	20-Sep	9-Oct
Somerset	15-Mar	3-Aug	15-Aug	28-Aug
	1-Apr	7-Aug	20-Aug	2-Sep
	15-Apr	13-Aug	26-Aug	8-Sep
	1-May	20-Aug	2-Sep	18-Sep
	15-May	29-Aug	12-Sep	1-Oct
	1-Jun	12-Sep	1-Oct	27-Oct
Lexington	15-Mar	8-Aug	21-Aug	3-Sep
	1-Apr	11-Aug	24-Aug	7-Sep
	15-Apr	16-Aug	29-Aug	12-Sep
	1-May	22-Aug	4-Sep	21-Sep
	15-May	30-Aug	14-Sep	6-Oct
	1-Jun	13-Sep	4-Oct	19-Oct
Covington	15-Mar	11-Aug	24-Aug	4-Sep
	1-Apr	14-Aug	27-Aug	7-Sep
	15-Apr	18-Aug	1-Sep	13-Sep
	1-May	25-Aug	7-Sep	22-Sep
	15-May	2-Sep	17-Sep	14-Oct
	1-Jun	15-Sep	7-Oct	26-Oct

[1] Date to reach black layer based an average of growing degree day calculations for each year from 1995 through 2004 from the University of Kentucky Ag Weather Data Center.

concern in Kentucky, especially in low-lying areas near river and creek beds. Two viruses, maize dwarf mosaic virus and maize chlorotic dwarf virus, both are problematic in fields infested with johnsongrass. When selecting a hybrid with tolerance to one or more of these diseases and viruses, be sure to select a hybrid that yields well.

Planting Practices

Planting Date. Corn seeds need soil temperatures at or above 50 degrees F for proper germination and development of the young seedling. Ideal planting dates are from April 1 to May 1 for corn in western Kentucky and April 15 to May 15 for central and eastern Kentucky. These dates provide a balance between planting a crop early enough to maximize growth but late enough to avoid frost or freeze injury. A 1 percent per day grain yield loss (one bushel per day on a 100 bushel yield) can be expected when planting is delayed past May 15. Potential grain yield loss from late plantings is important to silage corn because the ear provides approximately one-third of the total forage weight at harvest.

Planting Depth. Corn seeds need to be placed in warm, moist soil for good germination. Typically, corn planted 1 ½ to 2 inches deep is ideal. For early planting, especially when the soil is cool and wet, the ideal depth may be slightly less, 1 to 1 ½ inches. When the surface soil is dry, as is sometimes the case when planting is delayed, seeds may need to be planted 2 ½ to 3 inches deep to get the seed to moisture. Careful control of planting depth will not only improve stand levels but will also mean more uniform emergence.

Seeding Rate. Seeding rates for silage production range from 24,000 to 30,000 seeds per acre depending on the productivity of the soil (Table 3). Higher seeding rates should be used for very productive soils while the lower rates should be used on less productive soils.

Table 3. Corn population planting guide.

Seeding Rate (Seeds/A)	Row Width (inches)[1] 20	30	36	38
	Space between kernels in a row (inches)			
24,000	13.1	8.7	7.2	6.9
26,000	12.1	8.1	6.7	6.4
28,000	11.2	7.5	6.2	5.9
30,000	10.4	7.0	5.8	5.5

[1]The University of Kentucky recommends corn in 30- or 36-inch rows. Other row widths are included as a reference.

Soil Preparation

No-Till. For most Kentucky soils, no-till production is recommended to reduce erosion, improve soil organic matter and improve soil quality. In a no-till system, tillage is not done to the soil before planting. A very small amount of tillage occurs when the disk or coulter of the planter unit cuts through the soil to plant the seed. No-till production does require effective management of weeds. Weeds should be effectively controlled or "burned down" prior to planting. The extra plant material on the soil surface in a no-tillage field promotes insect survival more than tilled fields. As a result, a soil insecticide may need to be applied at the time of planting.

Tillage. For fields that tend to stay wet longer in the spring and have little to no slope, tillage is a viable option. In these cases, tillage with a field cultivator is preferred over other tillage systems. Tillage with a disk will cause smaller soil particle sizes and increase the chances for compaction. However, using a disk is better than using a moldboard plow, because the moldboard plow reduces soil organic matter and soil porosity faster than any other tillage implement. In most cases, the moldboard plow should not be used for corn production.

In dual-purpose hybrids, the ear will compose one-third of the total forage weight when harvested for silage.

Deep ripping is an option for fields that have a compaction layer beneath the soil surface but above the depth of the ripper shank. Deep ripping should occur only in fields where the compaction layer can be alleviated by the deep ripping implement. Soils should be deep-ripped when the soil is dry to maximize shattering and alleviation of the compaction layer. Because soils are usually dry in the fall, most deep ripping should occur during the fall.

Soil Testing. The soil cannot provide all the nutrients necessary for high-yielding corn. Soil tests should be conducted to determine the amount of lime, phosphorus, potassium, and possibly zinc needed for a productive crop. Understanding the soil drainage class of a field will help in making nitrogen applications. Consult the most recent University of Kentucky bulletin, AGR-1, *Lime and Fertilizer Recommendations*, for soil fertility recommendations.

Lime. Lime is used to neutralize soil acidity. Corn grows well in soil with pH levels near or slightly above pH 6.2 and below pH 7. The soil pH must be adjusted to the proper levels before maximum nutrient uptake can occur. The neutralization process of lime increases the availability of the essential nutrients to the plant. Lime should be applied in the fall to allow the neutralization process to occur before the next corn crop is raised. Lime applications in the spring will only provide partial benefit to the immediate crop. Usually, lime applications are made at high enough rates to require applications once every three or four years.

Many soils in Kentucky are slightly acidic. In addition, soil fertility applications of fertilizer nitrogen will acidify the soil. The soil pH will need to be checked every two or three years to determine if pH levels are adequate for corn growth.

Nitrogen, Potassium, and Phosphorus. Nitrogen (N), phosphorus (P), and potassium (K) are most likely to limit corn production in Kentucky. Manure contributes all three nutrients and, when available, should be considered for use in a fertility program. Manure can be checked for the amount of N, P, and K available. Manure applications should be applied to soils based on the nutrient value of the manure and the fertility requirements of the soil.

Nitrogen is the most limiting plant nutrient for corn production and it must be applied each year. N is essential to corn's growth and reproduction and is an essential part of all proteins made by the plant. The heaviest demand for N extends from about two weeks before to three weeks after tasseling. Approximately one-half of the total N requirement is absorbed during this period. Only small amounts of N are taken up during the first 35 to 40 days after planting. Nitrogen deficiency in corn is characterized by stunting and yellowing of bottom leaves. Yellowing begins at the leaf tip and progresses up the midrib of the leaf.

Phosphorus is essential for cell division, which is essential to plant growth. If the supply is limited, the rate of cell division is slowed and plants remain stunted and spindly. Phosphorus also acts as an energy carrier, providing the energy needed to change sugars to starch within the plant. Symptoms of P deficiency are not easy to recognize. In very early stages of growth, plants may be stunted and have a dark green color. In some strains of corn, a purple color may develop from the accumulation of sugars within the plant. Phosphorus deficiency at later growth stages may delay silking and result in incomplete pollination. At maturity, about 80 percent of the total plant P is in the grain.

Potassium is essential for the early stages of corn growth. Corn absorbs more K than any of the other elements during the first 60 days of growth. Potassium is essential for such processes as formation of simple sugars and starches, translocation of carbohydrates, reduction of nitrates, formation of proteins, and normal cell division. The K concentration of the grain is low when compared with other parts of the plant. At maturity, usually less than 25 percent of the total plant K is in the grain. Because large amounts of potassium are removed with silage harvest, the soil should be tested every two years to assure proper soil levels. Potassium deficiency in young plants results in yellowish-green leaves. Deficiencies later in the season result in leaf margins and tips that gradually turn brown and die, resulting in lower yields. Ears from K-deficient plants are small, poorly filled, and chaffy. Stalks may be weak and subject to stalk rot, which causes stalk lodging and excessive harvest losses.

Micronutrients. Zinc (Zn) is the most commonly occurring micronutrient deficiency that can be observed in corn grown in Kentucky. This deficiency is commonly associated with soils having a pH above 6.4 and a high level of available P. Soil tests will help determine if Zn is needed. Typical Zn deficiency symptoms are light yellow streaks between the veins in young seedlings and purpling of the nodes within the stalk. Cool air temperatures and slow growth can also cause corn to display Zn deficiency symptoms even when Zn is available. If the weather is cool, and Zn levels are adequate, additional fertilizer Zn will not improve the situation. Once soil temperatures rise, the Zn deficiency symptoms will disappear. If a soil test indicates that Zn needs to be applied to the field, then banding Zn at planting is the most economical method. Foliar applications of Zn will reduce deficiency symptoms, but are much more expensive.

Competition from weeds such as johnsongrass can drastically reduce corn forage yields.

Pest Management

Weeds. Weeds compete with corn for nutrients, water, and sunlight. They harbor insects and diseases, and weeds may create harvesting problems. Weed control is a major factor in profitable corn production. Knowing which weeds occur in your field is the first step to effective weed control.

Selection of the proper herbicides for good chemical weed control depends on several factors: (1) the type of weed species expected during the growing season—broadleaves or grasses, annuals or perennials; (2) the correct time to apply herbicides—preplant foliar to existing vegetation, preemergence, or postemergence; and (3) the crop following corn harvest in the crop rotation system.

Postemergence herbicide application has become a very popular method for controlling weeds in corn. Most herbicides applied to a standing corn crop have crop growth stage restrictions. These corn growth stage restrictions must be strictly followed for specific herbicides, otherwise crop injury and yield losses can be possible. Most herbicide labels provide a plant height limitation and/or a crop growth stage limitation. In most cases the crop growth stage limitation will be reached first. Anyone spraying postemergence herbicides must know the crop growth stage of the corn before spraying occurs. If the corn is past the growth stage limit, then drop nozzles can be used in some situations. Check the herbicide label to determine if drop nozzles are allowed.

Each year, the University of Kentucky bulletin AGR-6, *Chemical Control of Weeds in Farm Crops in Kentucky* is updated with the latest herbicide formulations, labels, and recommendations. Refer to the most recent edition of this publication when making herbicide decisions. This publication can be found at the county Extension office or online at the University of Kentucky Weed Science Extension Web site, <http://www.uky.edu/Ag/Agronomy/Weeds/>.

Insects and Diseases. Insects account for major losses of corn each year. The use of a soil insecticide at planting is an important part of corn production, especially in no-till fields. The first insects that your corn may encounter are the soil insects. These include wireworms, root aphids, rootworms, white grubs, and cutworms, which damage corn plants either beneath the soil or at the surface. Fields planted in continuous corn or following sod often have more soil insect problems.

Insects that attack growing or mature corn include armyworms, European and Southwestern corn borers, flea beetles, cutworms, earworms, and adult rootworms. Systemic soil insecticides will reduce the damage from some of these insects. However, when serious damage is occurring, the insect must be identified and proper application of foliar sprays is necessary to control it. Insecticide recommendations are updated in the "Insect Management Recommendations for Field Crops and Livestock," which is available online at <http://www.uky.edu/Ag/GrainCrops/corn.htm>. Click on "Insects" to get to the management guide.

Corn diseases are capable of attacking all parts of the plant during all stages of growth. The most serious diseases of field corn are the stalk rots. Stalk rots, caused by fungi, weaken the stalk resulting in severe lodging. Lodged corn is normally difficult to harvest by machine and, therefore, large losses may occur. Stalk rot problems are most severe when plants have been subjected to other stresses, such as insects, other diseases, drought, excessive plant population, or unbalanced fertility programs. Two other diseases of special note in Kentucky are gray leaf spot (Cercospora) and *Anthracnose*. The effect of these diseases on total yield is directly related to the stage of development when the disease strikes. Both diseases have a leaf and stalk rot phase and become increasingly serious as the corn matures. The best control of these diseases is the use of tolerant hybrids and good cultural practices.

Virus diseases such as maize dwarf mosaic (MDM) and maize chlorotic dwarf virus (MCDV) can also cause serious yield losses. Both of these viruses are transferred from johnsongrass to corn by insects. These viruses cause stunting, discoloration of the corn plant, and reduced corn yields. To reduce losses from these diseases, plant virus-tolerant corn hybrids and use weed control methods that effectively control johnsongrass.

Crop Rotations. Rotation from corn to other crops can help reduce pest pressures and improve yields. Corn following soybeans will yield better than corn following corn in most every situation. The only exception is in severe drought years. In severe drought years, corn following corn may yield more than corn following soybeans. Scientists think that in drought years, the additional biomass from the previous corn crop helps capture moisture, which benefits the current corn crop. Corn following grass-legume forages is another system that will provide excellent corn yields, provided that weeds are adequately controlled and the grass-legume sod is killed prior to planting corn. Grass-legume sod is the only rotation crop in Kentucky where a nitrogen credit is given; meaning that less nitrogen is needed for corn following grass-legume sod than for corn following any other crop.

Even though corn yields best when rotated with other crops, many fields devoted to corn for silage have been in continuous corn for numerous years. Some farmers grow wheat for silage between each of the corn crops. In these fields, corn hybrids must have good disease-tolerance traits for maintaining high silage yields. In the continuous corn fields (or corn-wheat-corn fields) grown for silage, nitrogen (N) applications are needed each year and potassium (K) removal will be high. The frequent N application will increase the acidity of the soil and will require frequent soil sampling to determine when lime is needed. The K removal will require frequent soil tests and additional K applied to the soil.

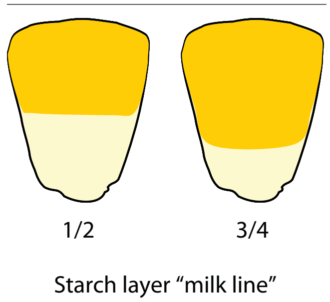
While continuous corn fields require frequent soil sampling to ensure proper adjustments to soil fertility, the greater challenge in continuous corn for silage is likely soil compaction. The travel of forage harvester and wagons across these fields can cause compaction. Fields should be examined for compaction when the soil moisture is close to field capacity. Field capacity usually occurs when the field that has dried for 48 hours following complete saturation of the soil. Soils at field capacity are too wet to till, but there is no standing water. For information on identifying and alleviated soil compaction, consult University of Kentucky bulletin ID-153, *Assessing and Preventing Soil Compaction in Kentucky*.

Silage Management

Harvesting

Moisture Concentration and Crop Stage. Corn should be harvested at or near 65 percent plant moisture and just prior to black layer for optimum silage quality and yield. Corn forage that is going to be ensiled in horizontal or bunker silos should be harvested when plant moisture is at 65 to 70 percent. Once the kernel dents, a starch layer progresses from the top of the kernel to the bottom of the kernel. When this starch layer spans one-half to three-fourths of the kernel (Figure 1), then the corn is ready to harvest for silage. Slightly more tonnage can be obtained if the corn is allowed to reach black layer before harvesting, but the extra tonnage is offset by a reduction in silage quality. Black layer occurs after corn kernels have dented at the top and a black layer forms at the bottom.

Figure 1. Schematic of the starch layer (often referred to as the milk line) progressing from the top of the kernel (dented end) to the base.



Two different methods can be used to determine the moisture concentration of corn. The microwave method provides a fairly accurate estimate of crop moisture but requires scales, a microwave, and people who do not mind the smell of burnt corn in the microwave. Collect a representative sample of fresh plants. Chop the plants in 1- to 2-inch pieces. Weigh a sample (about 3 to 4 ounces or 100 grams). The weight of the sample will be referred to as the fresh weight. Spread the sample uniformly and thinly over a microwave safe dish and place in microwave oven. Place a cup of water in the microwave with the corn sample to prevent fire. Heat for one to two minutes and weigh. Heat for 30 seconds and reweigh. Repeat until two weight recordings are similar. If the sample chars, use the previous weight. This final weight is referred to as the dry weight. Calculate the percent moisture with the following equation:

[(fresh weight – dry weight)/fresh weight] x 100 = percent moisture

For example, the fresh weight of a sample is 100 grams (3.52 ounces). The sample is heated in the microwave for two minutes. The weight of the heated sample is 40 grams (1.41 ounces). The sample is heated for 30 seconds. The weight of the sample is 35 grams (1.23 ounces). The sample is heated for another 30 seconds and the weight of this sample is 32 grams (1.13 ounces), but the sample was slightly charred. The dry weight is 35 grams. Moisture concentration is calculated as:

[(100 grams – 35 grams)/100 grams] x 100 = 65 percent moisture

Another method for determining moisture concentration in forage is the Grab Test Method and is conducted in the field. This method is outlined in Table 4.

There are occasions when events, such as rainfall, prevent the proper harvest timing of corn for silage. Corn forage that is too dry will need extra water added to prevent mold from developing in storage. The high volume of water required to improve moisture concentrations of the ensiling forage is often very difficult to achieve. However, if the forage is dry, then adding water may help salvage some of the forage. As a rule of thumb, add 4 to 6 gallons of water per ton of wet forage for each 1 percent desired rise in moisture concentration. The water should be added to the forage as it is being loaded into the silo. For upright silos, the water can be added through the blower. For bunker silos, the water can be added as each foot of corn forage is being added.

For example, you plan to ensile 100 tons of corn forage in a bunker silo. The corn forage is at 58 percent moisture and you want to increase the moisture concentration to 65 percent. The difference between the desired moisture and actual moisture is 7 percentage points. Using the rate of 4 gallons, you would need 28 gallons of water to raise the moisture concentration of each ton of wet silage from 58 percent to 65 percent. For the entire silo, you would need 2,800 gallons of water. If using the 6 gallons rate, then you would need 42 gallons of water per ton or 4,200 gallons of water for the entire bunker.

If the corn is harvested when it is too wet, excessive drainage during the ensiling process will leach away valuable nutrients. Dry plant material can be added to the corn to help adjust the moisture. Alfalfa or grass hay that has been chopped and ground can be added to the corn. Typically, 150 to 200 pounds of dry, chopped hay added to 1 ton of wet forage will decrease the moisture concentration of wet forage approximately 5 percentage points.

For example, you plan to ensile 100 tons of wet corn forage in a bunker silo. The corn forage is at 74 percent moisture and you would like to reduce the moisture concentration to 70 percent. The difference between the desired moisture and actual moisture is 4 percentage points. Using the rate of 150 pounds, you will need to add 600 pounds of dry hay to reduce each ton of wet corn forage from 74 percent to 70 percent moisture. For the entire silo, you will need 60,000 pounds of dry hay.

The silage should be chopped at a length of approximately 3/8 to 1/2 inch. Corn chopped to these lengths will help ensure proper fermentation by releasing plant juices and permitting better packing for oxygen exclusion.

Storing. A silo is any storage structure in which green and moist forage is preserved in the absence of air and water. Excluding air is of major importance in making and preserving silage. Oxygen lowers silage quality by allowing destructive microbial and chemical action to take place. Excessive water also lowers silage quality by increasing chemical and microbial changes that lower nutrient content of the silage. In addition to damage resulting from air and water, silos must also protect the silage from damage by rodents, birds and animals.

Two basic principles must be practiced regardless of silo type: 1) fill fast and 2) pack well.

Inoculants. Inoculants are not recommended for top-quality corn silage. While some inoculants have worked with ensiling other forages, there is no consistent result from any of the inoculants in corn silage. While most bacterial inoculants are successful at reducing pH quickly, they also decrease the silage stability. The exception to this is *Lactobacillus buchneri*, which lowers the pH and improves stability of silage once exposed to air. If improper packing were a concern or delays between feed-outs were to occur, then *L. buchneri* may help reduce silage losses.

Table 4. Field technique for estimating moisture content of forage.

Approximate Moisture Content	Condition of Forage Ball
Over 75%	When the ball holds its shape and there is considerable free juice
70 to 75%	When the ball holds its shape but there is very little free juice
60 to 70%	When the ball falls apart slowly and there is no free juice
Below 60%	When the ball falls apart rapidly

Table 5. Nitrate concentrations and feeding instructions.

Nitrate (NO_3) in dry matter	Feeding Instructions
0.0-0.44%	Safe to Feed
0.44 – 0.88%	Limit to 50% of total dry ration for pregnant animals.
0.88 – 1.50%	Limit to 25% of total dry ration. Avoid feeding pregnant animals.
Over 1.50%	Toxic. Do not feed

Nonprotein nitrogen may be added to increase protein content. Anhydrous ammonia is one source of nonprotein nitrogen and can be added at 6 to 8 pounds per ton of forage. If corn forage will be packed into a horizontal (bunker) silo, then the anhydrous ammonia should be added while chopping. If the corn forage is going into upright silos, then anhydrous ammonia should be added through the blower. Both techniques require extreme caution as anhydrous ammonia gas is lethal. 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. Additionally, molasses and grain provide energy, which is rarely a limiting factor for corn silage.

Silo Gases. Lethal gases may occur in upright silos at any time during filling, but the greatest danger is during the 12 to 72 hours after filling. Silo gases may be present in any ensiled material, grown on any type of soil under any level of fertilization.

Two of the most dangerous gases may be recognized by their irritating odor and color. Nitrogen dioxide is reddish brown and nitrogen tetroxide is yellow. A third gas, nitric oxide, is colorless and may be present and undetected at lethal concentrations. A few simple precautions will prevent tragedy or injury from silo gases:

1. Run the blower 15 to 20 minutes before going into a partly filled silo. The blower should be running as long as anyone is inside.
2. Stay out of the silo for at least one week (preferably two weeks) after it has been filled.
3. Ventilate the silo room for at least two weeks after filling.
4. Keep the doors between the silo room and barn closed to protect livestock.
5. If you experience the slightest throat irritation or coughing, get into fresh air immediately. Immediate treatment by a doctor is an absolute must.

Harvesting Drought-Stressed Corn for Silage. Drought-stressed corn that is unlikely to resume growth should be ensiled. Harvesting drought-stressed corn should result in 85 to 100 percent of the normal net energy content. This corn may contain more crude protein than corn harvested under less stressful conditions. This corn may also contain high nitrate concentrations, especially in the lower third of the plant. The ensiled corn should not be fed until at least three weeks after the silo has been filled. At high enough concentrations, nitrates are poisonous to cattle. Ensiling reduces nitrate levels by 30 to 50 percent. The University of Kentucky Livestock Disease Diagnostic Center has testing kits available free of charge to county Extension offices for testing corn for nitrates. These kits will provide an estimate for the level of nitrates in the corn before harvest or in the corn after ensiling. If the kit indicates a high level of nitrates, then a sample should be sent off for further analysis prior to feeding.

Summary

Successful corn silage production can be achieved by starting with high-yielding, well-adapted hybrids that meet the maturity requirements for your operation. Proper seeding rates, planting dates, soil fertility, and pest management are required to achieve maximum yields. Timely harvest when the corn kernels have dented and reach one-half to three-fourths milk line is necessary for getting the highest quality silage. Inoculants typically are not necessary, unless poor packing or extreme lag times between feed-outs occurs. In these cases, live cultures of *L. buchneri* have provided the best results. Drought-stressed corn can be salvaged as silage but must be checked for nitrate levels before feeding to livestock.

Resources

Bukmaster, D. R. and K. D. Vandervort. Silo Capacities, H-70. Pennsylvania State University Cooperative Extension.

Combs, D.K. and P.C. Hoffman. 2001. *Lactobacillus buchneri* for Silage Aerobic Stability. Focus on Forage. Vol. 3, Issue 14. University of Wisconsin Board of Regents.

Neild, R.E. and J. E. Newman. 1990. Growing Season Characteristics and Requirements for the Corn Belt. NCH-40. National Corn Handbook. Purdue University Cooperative Extension Service.

Schroeder, J. W. 2004. *Silage fermentation and preservation*, AS-1254. North Dakota State University Extension Service.

Schuler. R. Adding Anhydrous Ammonia to Corn Silage. Focus on Forage. University of Wisconsin Board of Regents.

Vincelli, P. and R. Bessin. Virus Diseases of Corn in Kentucky, PPA-40. University of Kentucky Cooperative Extension Service.

Wheaton, H.N., F. Martz, F. Meinershagen, and H. Sewell. 1990. G4590, Corn Silage. University of Missouri Extension.

Photos: Chad Lee © 2005 University of Kentucky