AGR-79
PRODUCING CORN FOR GRAIN & SILAGE
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In Kentucky, corn is king, at least in the amount of land devoted to the crop. Figures from 1978 reveal that nearly 1.6 million acres were planted in this valuable crop which can be either fed to livestock as grain or silage, or sold for food and industrial purposes. Corn adds more than $250 million to Kentucky's economy, ranking it second behind tobacco in value to the farmer. It should be noted that this dollar figure is a bit deceiving when one considers that much of the corn crop value is not shown in cash receipts when it is directly marketed through livestock.

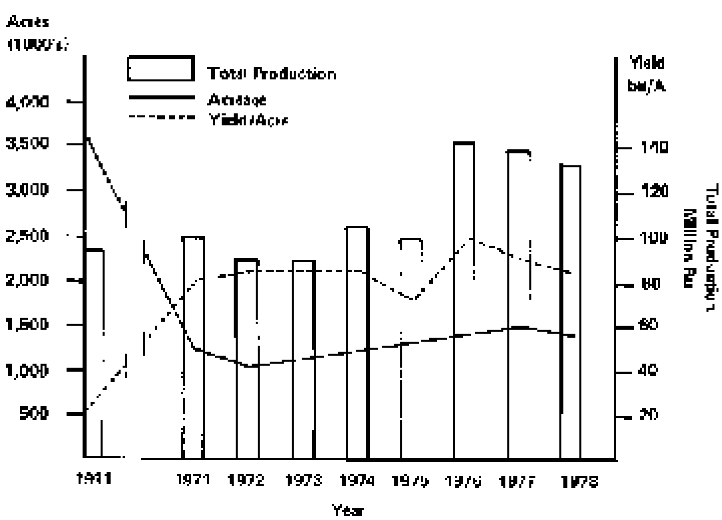

Figure 1. Acreage and Corn Yields in Kentucky.

Corn acreage in Kentucky reached a peak of 3.6 million acres in 1911, but steadily declined to 1.0 million acres by 1970. Since that time, however, corn acreage has steadily increased to nearly 1.6 million acres. Average corn yields have also improved resulting in sharply increased total grain production **(Figure 1)**.

In a recent report titled Agricultural Potentials for Kentucky, compiled by the University of Kentucky for the Governor's Council for Agriculture, a recommendation was made for increased corn production to increase Kentucky farmers' income. This report indicated that the potential corn acreage in Kentucky is about 2.7 million acres or over 1 million acres more than is now being produced. High yields of corn result from selecting the best hybrids and fertilization practices; by choosing the best tillage and planting procedures; by selecting the proper weed, insect and disease control; and by employing the most efficient harvesting and marketing programs.

Land Selection

Corn does well on a wide variety of soils but performs best on silt loam soils that are well-drained, in good tilth and free from erosion or, at least, properly managed to reduce erosion. Corn can be grown either in a definitely planned rotation with other crops or on a continual basis for many years, depending on soil conditions and management level. No two farms or two fields are exactly alike, so the first step toward top yields is to learn the physical and chemical properties of each field of your farm. Determine what each field is capable of producing and use it for the best suited crop.

Tillage Systems

Seedbed Preparation

Traditionally corn has been planted in a seedbed that has been tilled 3 or 4 times. Because reduced tillage lowers the cost of growing the crop, uses less fuel energy and minimizes destruction of the physical conditions of the soil, it is strongly recommended that land preparation be reduced to a minimum.

Corn kernels need a soil that is warm (above 50 degrees F), moist, well supplied with air, and firm enough to give good contact between the seed and soil.

Conventional Tillage

The traditional and most widely used tillage system for corn consists of plowing with a moldboard plow in the fall or spring followed by one or more secondary tillage operations. However, the following questions should seriously be considered. Is all of this tillage necessary? Is soil being lost through erosion on sloping lands? Is too much energy being used? In many fields, some form of reduced tillage should be considered.

There are only a few good reasons for plowing or heavily tilling a soil for corn: **(1)** a perennial weed problem that must be controlled by incorporated chemicals; **(2)** wet, clayey type soils that will not allow air or water movement or do not warm up until very late in the spring, and **(3)** incorporation of residues, when necessary.

No-tillage

There are many good reasons for using no-tillage methods for producing corn: **(1)** soil tilth is better maintained; **(2)** land too steep for conventional tillage methods may be utilized for corn production; **(3)** more moisture will be available during drouth stresses; **(4)** less energy and labor are required to produce the crop; and **(5)** most importantly, corn yields are equal or higher than conventionally planted corn (Table 1).

However, successful no-tillage requires a more intense level of management since most practices involved can't be repeated if they fail the first time.

Table l.-Yields of no-tillage and conventionally planted corn on several soils in Kentucky

Soil Type	**No. of years tested**	**--------Yields (Bu/A)--------**	
	No-till	**Conv**	
Maury silt loam	8	134	131
Crider	5	145	122
Tilsit silt loam	5	113	113
Allegheny silt loam	3	161	160
5 soils*	1	130	120

**Donerail, Granada, Loradale and Lowell silt loams, Faywood silty clay loam all compared in 1969.*

Hybrid Selection

Selecting hybrids is one of the most important decisions a corn producer must make each year. The yield difference between a good and a poor hybrid can mean the difference between profit and loss. The results from the Kentucky Hybrid Corn Performance Test provide an excellent starting place for selection of hybrids. These tests are conducted at several locations in the state and the results are presented in an annual progress report. At each location over 100 hybrids are evaluated using methods and equipment similar to those of farmers in the area. Other dependable sources for obtaining hybrid performance information include tests made by seed companies, your neighbors and yourself. A very important consideration in selecting a hybrid is how consistent it performs from year to year. This factor alone gives an indication of stress tolerance and disease and insect resistance. In addition to yield, be sure to check maturity, standability, and disease resistance.

Single-crosses or modified single-crosses now dominate the market. Selecting between a single cross three-way or double-cross should be based on performance and price. For the new plateless-type planters, seed size is not an important consideration. For plate-type planters, seed size and plate size should be matched to give accurate planting. Seed of any size or shape has the same genetic potential within a given hybrid.

If you are growing a fairly large acreage of corn it is wise to select hybrids that vary somewhat in maturity. This can serve as a hedge against stress at pollination time and spread the work load in the fall. In general, full-season hybrids are the highest yielding. Some earlier hybrids will approach full-season hybrid yields and will be ready for harvest several days sooner. Full-season hybrids should be planted first.

Based on the days-to-maturity rating system, the average full-season hybrid for Kentucky matures in 115-120 days. However, you should be warned that full-season and mid-season hybrids may vary from one company and/or area to another. Grain moisture at harvest as reported in the Kentucky Hybrid Corn Performance Test can be helpful in maturity comparisons between hybrids. The earlier maturing hybrids will show a lower moisture content than a later maturing hybrid.

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 has recently been proposed and is being adopted by most corn companies. The growing degree day (GDD) approach is a method of predicting corn maturities based on mean daily temperatures during the growing season. A particular hybrid has a rather specific growing degree requirement, sometimes referred to as the varietal constant. By knowing the varietal constant for various hybrids, it is possible to choose a hybrid that will have a reasonable chance of maturing before frost. A full-season hybrid in Kentucky has an average GDD of 2650-2700. For complete details on this new method of determining corn maturities, refer to Progress Report 197, "Growing Degree Days for Corn in Kentucky." [1]

Planting Practices

Date of Planting and Planting Depth

In recent years a decided trend has been toward earlier planting. Earlier planted corn has outfielded late planted corn and has had fewer insect and disease problems. In order to reduce yield losses, it is important to finish planting corn before May 1 0 in western Kentucky and May 20 in eastern Kentucky.

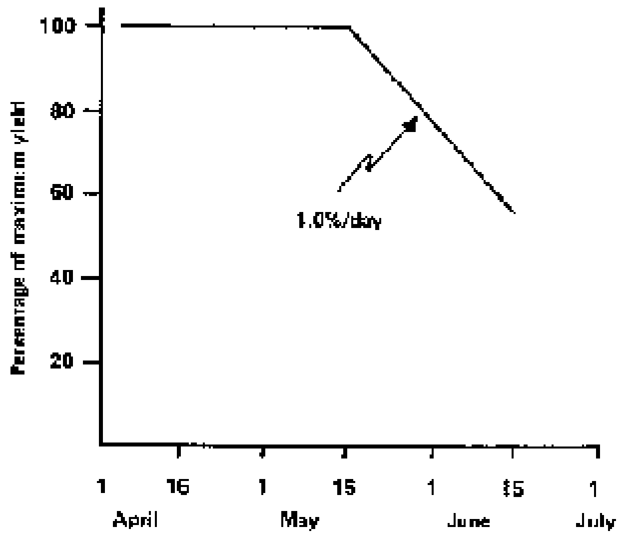

Figure 2. Effect of planting date on corn yields.

As shown from several planting date studies in Kentucky conducted over several years, a 1 percent per day yield loss (one bushel per day on a 100 bushel yield) can be expected when planting is delayed past May 15 **(Figure 2)**. Flow early you start depends on soil conditions, acres to be planted and work days available. A good guide for earliest starting time is to watch for the soil temperature to rise above 50')F for several days. Soil does not warm up as rapidly for no-tillage planting as it does for tilled soil. Where planting is delayed past June 1, hybrids classified earlier than "full-season" should be used, especially in central and eastern Kentucky.

Ideal planting depth depends on soil and weather conditions. For average conditions, a 1 1/2-2 inch depth is ideal. For early planting, especially when the soil is cool and wet, the ideal depth may be slightly less. When the surface soil is dry, as is sometimes the case when planting is delayed, you may have to plant 3 inches or slightly deeper to get the seed to moisture. Depth is particularly critical in no-tillage planting. Careful control of planting depth will not only improve stand levels but will also mean more uniform emergence.

Plant Population

Poor or inadequate stands is still one of the most limiting factors in producing top yields. In recent research studies at the University of Kentucky, slightly higher plant populations for no-tillage planted corn yielded more, with less incidence of lodging, as compared to conventional planted corn (Table 2). In two out of five years, lodging was sharply higher at plant populations above 20,000 per acre. The recommended planting rates for consistent top yields are as follows:

Conventional	- 18-22,000 kernels/acre
No-tillage	- 20-26,000 kernels/acre
Silage	- 20-28,000 kernels/acre

Table 2.-Effect of plant population and row width on notill and conventionally planted corn yields and lodging[1]

	Yields (Bu/A)		**% Lodging**	
	No-till	**Conv.**	**No-till**	**Conv.**
Plants/Acre	**1972-74**	**1973-74**	**1973**	
14,000	142 a[2]	126 a	3.4 a	7.5 a

[1] Obtain the publications listed from your local county extension office.

20,000	166 b	134 b	9.6 a	31.2 b
26,000	177 c	146 c	22.8 b	39.9 b
	1975-76		**1975**	
18,000	119 a	102 a	21.0 a	13.0a
23,000	121 ab	104 ab	25.0 a	14.0 a
28,000	127 b	111 b	21.0 a	20.0 b
Row Width	**1972-74**	**1973-74**	**1973**	
18 in	161 a	138 a	10.5 a	22.3 a
36 in	162 a	133 a	13.3 a	30.1 b
	1975-76		**1975**	
30 in	117 a	--	31.0 b	--
38 in	123 a	106	22.3 a	15.7

[1]5 year study in Hardin County on a Crider silt loam soil.
[2]Values followed by the same letter within a given date and tillage method do not differ significantly at the 5 percent level.

For planting at the upper range of these recommendations, such factors as adequate soil moisture, a high yield goal, high productive soil, high fertility and top management should exist. Table 3 presents a corn planting guide for various row widths and expected final stands. If your final stand is less than 16,000 plants per acre, top yields cannot be expected. When planting very early or using an early maturing hybrid, you can plant up to 2,000 more kernels per acre because of more seedling mortality, shorter plants with less lodging and more adequate moisture supply expected.

Table 3.-Corn Population planting guide.

Harvest Population of [1]	**Requires Planting rate of**	**Inches Between Kernels When Planting at Various Row Widths**				
	20"	**30"**	**36"**	**38"**	**40"**	
14,400	16,000	19.6	13.2	10.9	10.4	9.8
15,300	17,000	18.4	12.4	10.2	9.8	9.2
16,200	18,000	17.4	11.7	9.7	9.2	8.7
17,100	19,000	16.5	11.1	9.2	8.7	8.2
18,000	20,000	15.7	10.5	8.7	8.3	7.8
19,800	22,000	14.3	9.5	7.9	7.5	7.1

21,600	24,000	13.1	8.7	7.2	6.9	6.5
23,500	26,000	12.1	8.1	6.7	6.4	6.0
25,200	28,000	11.2	7.5	6.2	5.9	5.6

[1]Allows 10 percent stand loss.

Row Width

Rows narrower than 36 inches have not shown a yield advantage in Kentucky. A 5-year research study (1972-76) comparing row widths of 38, 36, 30 and 18 inches on a Crider silt loam soil showed no differences between row widths for corn grain yields (Table 2).

The 36- or 38-inch row width gives optimum yield and allows for easier machine operation and emergency weed control measures. Also, a 36- or 38- inch row is most practical in Kentucky since the planter can be converted to a row width of 18 or 19 inches for planting double-cropped soybeans by simply adding additional units.

Fertilizer is the largest out-of-pocket expenditure for corn production. With the cost of fertilizer having greatly increased over the past few years, applying the exact amount of the correct nutrients is very important. So don't guess, SOIL TEST. The soil test and field history provides the best information for determining the fertilizer and lime needs for your crop. Your county extension agent can supply you with soil sample boxes and instruction for getting your soil tested.

Nitrogen, phosphorus and potassium 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. For more information on the value of manure, obtain a copy of the publication ID-19, "Farm Manure." [1]

Function of Nitrogen

Because of corn's high requirement for it, nitrogen (N) is often the most limiting plant nutrient for corn production. N is essential to corn's growth and reproduction. It plays a major role in the development and function of protoplasm and is an essential part of all proteins. 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 35-40 days after planting. N 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.

While a soil test is the most reliable basis to determine needs for phosphorus and potassium, University of Kentucky N recommendations are based on soil type and drainage, tillage method and crop rotation. For most efficient N utilization, consider delayed application of N four to six weeks after planting. Delayed application is especially important for soils with poorer drainage or soils which tend to waterlog after rains. For additional information on N refer to the publication, AGR-43, "Nitrogen in Kentucky Soils."[1]

Function of Phosphorus

Phosphorus (P) is essential for all cell divisions. If the supply is limited, the rate of cell division is slowed and plants remain stunted and spindly. P also acts as an energy carrier, providing the energy needed to change sugars to starch within the plant.

Symptoms of 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. In later stages P deficiency may delay silking and result in incomplete pollination. At maturity about 4/5 of the total plant P is in the grain.

Function of Potassium

Potassium (K) is essential for early corn growth. Corn absorbs more K than any of the other elements during the first 60 days of growth. Although not much is known about the function of K in the plant, it 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 content of the grain is low when compared with other parts of the plant. At maturity, usually less than 1 /4 of the total plant K is in the grain.

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.

Lime and Micronutrient Requirements

Lime is used to neutralize soil acidity. Corn grows well in soil with pH levels near or slightly above pH 6.2. The neutralization process of lime increases the availability of the essential nutrients to the plant.

In Kentucky, the most commonly occurring micronutrient deficiency in corn is zinc. This deficiency is commonly associated with soils having a pH above 6.4 and a high level of available phosphorus. Typical zinc deficiency symptoms are light yellow streaks between the veins in young seedlings and purpling of the nodes within the stalk.

For the latest information on lime and fertilizer recommendations obtain a copy of the latest edition of AGR-1, "Lime and Fertilizer Recommendations."[1]

Weed Control

Not only do weeds compete with corn for plant food, water and sunlight but they also harbor insects and diseases as well as create harvesting problems. Weed control is a major factor in profitable corn production. The first step to effective weed control is knowing which weeds may occur in your field. Selection of the proper herbicides for good chemical weed control depends on several factors: **(1)** the kind of weeds expected during the growing season -- broadleaves or grasses, annuals or perennials; **(2)** the method of application used to apply the herbicides-incorporated or surface applied; **(3)** the correct time to apply herbicides -- prior to planting, pre-emergence or post-emergence; and **(4)** the crops to be planted following corn in the rotation. Even though a majority of farmers now depend on chemical control methods, the use of some type of cultivation, i.e., rotary hoe, spring tooth harrow or cultivator, may be advantageous where: **(1)** proper weed control is not obtained; **(2)** the soil has formed a thick, hard crust; and/or **(3)** rainfall is not timely or adequate to activate the herbicide.

Since herbicide recommendations change from year to year, you are referred to the most recent publication of AGR-6, "Chemical Control of Weeds in Farm Crops in Kentucky."[1]

Insect Control

Insects account for major losses of corn each year. The use of a soil insecticide at planting is becoming an important part of corn production. 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 many 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.

Since insect recommendations may change each year, farmers are urged to follow the recommendations in the most recent ENT-16, "Insecticide Recommendations for Conventional and No-Tillage Field Corn."[1]

Diseases and Their Control

Corn diseases are becoming an increasingly important factor in corn production. 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-insects, other diseases, drouth, too high plant population or unbalanced fertility programs. Two 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.

The virus diseases associated with Johnsongrass, maize dwarf mosaic (MDM) and maize chlorotic dwarf virus (MCDV) can cause serious yield losses. These diseases are transferred from Johnsongrass to corn plants by insects. They cause stunting, discoloration of the corn plant and reduced corn yields. To reduce losses from these diseases, plant virus-resistant corn hybrids and control the Johnsongrass.

For best control of corn diseases use good cultural practices, plant adapted and resistant hybrids, buy treated seed and practice crop rotation where build-up of disease is evident. To identify your disease problem, take a sample to your local extension office.

Harvesting and Storage

Approximately 85 percent of Kentucky's corn is harvested for grain. A major portion of the corn crop is field shelled with a combine or picker-sheller. However, mechanical pickers are still widely used in central and eastern Kentucky. Harvesting losses generally occur when certain portions of the combine are not operating satisfactorily. And when harvesting efficiency is not up to par, profits are lost. An average loss of two kernels per square foot equals one bushel per acre. For details on measuring corn harvest losses, obtain a copy of Leaflet 307, "Reducing Corn Harvest Losses."[1]

The best moisture to harvest corn depends on harvest method and storage availability. If corn ears are to be stored in a crib, harvesting should be delayed until the grain moisture content is below 20 percent. Field shelling should begin when grain moisture content is below 28 percent. Lowest field losses and highest yields will result when most corn is shelled between 20-26 percent moisture. Shelled corn harvested at high moisture content requires artificial drying to be stored as dry corn. In Kentucky, shelled corn should be stored at 13 percent moisture for safe storage.

On-farm storage and drying facilities for shelled corn allows the producer to maintain more control over the farming operation. Farmers are becoming increasingly aware of the opportunities available for cash or future contracting of their crop. Use your storage facilities as a marketing tool instead of simply as a place to store your grain. For information on the economics of corn drying, storage and other considerations, the publications AEN 29, AEN 33, AEN 34 and AEN 35 for various aspects of "Economics of Drying, Storage and Feed Processing" are available. For latest recommendations on insect control in stored grain, refer to ENT-19, "Controlling Insects in Stored Grain."[1]

Marketing the Crop

For too many years farmers have concentrated most of their efforts solely toward profitable production. Top farmers must begin to develop the knowledge and ability for profitable corn marketing. Such factors as price trends, hedging, forward contracting, market basis, cost of storing and day-today changes must be considered. This may require an average of 1 - 1 1/2 hours per day to accomplish. Many sources of information are available both from the university and private sector of industry. Only you can make the final decision on when to sell.

Residues as Livestock Feed

Residues left in the field following corn harvest can represent a relatively low cost source of feed for certain classes of livestock. With increasing prices for hay, grain and supplements, cow-calf producers have renewed interest in corn crop residues as winter feed for beef co%m. Using practical grazing techniques, it is estimated that from 80 to 100 grazing days per acre usually exist following grain harvest.

The corn plant has more than 50 percent of its weight in stalks, leaves, shucks and cobs. These components are left in the field following grain harvest and can result in more than three tons of dry matter per acre from a high yielding corn crop. Considerable grain may also remain in the field after combining. Even with conservative combining techniques four to six bushels per acre may remain. With this large amount of dry matter available, careful consideration should be given to feeding methods. Before a method of utilization is decided upon, consider the soil conditions of the field and erosion potential. If a decision has been made to utilize some or all of the residue, then a method of utilization should be reliable, practical and economical. Make sure that the method of utilization does not interfere with grain harvest, delay next year's planting date or result in increased soil loss.

Grazing

Grazing is by far the most common method for utilization of residues in Kentucky. Whole field grazing is wasteful. It results in a lower degree of utilization as animals waste a lot of the residue through selective grazing, trampling and over consumption. Restricted grazing results in more complete utilization.

Big Package Harvesting

In recent years large balers and stackers have been used for harvesting residues. This extra mechanization may increase the cost of the feed but it also prevents overgrazing of cover crops and may result in less waste than whole field grazing. Increased labor is required in both harvesting and feeding. Residue stored in big packages should be stored and fed in a manner that minimizes losses. Because the quality of corn residue is usually rather low, it is best suited as a feed source for dry brood cows. For more detail on feeding corn crop residue, see ID-9, "Salvage Feed for Beef Cattle."[1]

Corn Silage

Corn is considered "king of the crops" when it comes to producing top quality silage. Corn silage has the potential of producing more TDN per acre than any other crop. Both beef and dairy producers agree that there is more interest in silage production today than ever before. To produce top quality silage from corn, use most of the same good production practices recommended for grain production. A few differences for producing high quality corn silage are: **(1)** increase plant populations by 1,000-2,000 per acre; **(2)** add 60 pounds more potash per acre; **(3)** use a full-to-late season, high grain producing corn hybrid for higher quantity and quality.

Harvesting

The best time to harvest for high yield and quality is when the kernels have all dented and black layer formation is occurring. A black layer is formed near the base of the kernel when the kernel is physiologically mature. Harvesting for silage should be done in the first few days of this period while the leaves are still mostly green above the ear. The moisture content of the silage should be near 65 percent. If the crop is harvested at a stage when the silage is too dry, extra water must be added to prevent mold from developing in storage. If the silage is harvested too wet, excessive drainage from the silage will result in loss of most of the nutrients. When using trenches, bunkers or stacks, the moisture content of the silage should be above 65 percent in order to obtain adequate packing. The silage should be chopped at a length of approximately 3/8 - 1/2 inch. This will help insure proper fermentation by releasing plant juices and permitting better packing for oxygen exclusion. The result should be high quality silage. Table 4 describes a simple field technique for determining moisture.

Storing

A silo is any storage structure in which a 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.

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

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

Two basic principles must be practiced regardless of silo type-fill fast and pack well.

For more detailed information on silos (structure, type, loaders, unloaders, etc.) see University of Kentucky Publication Misc. 366, "Corn Silage."[1]

Preservation

Top quality corn silage can be made without the addition of any preservatives or additives. There is no reliable evidence that adding enzymes, yeast culture, antibodies or acid forming bacteria will economically increase the feeding value of corn silage. Non-protein nitrogen may be added to increase protein content.

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.

Silo Gases

Lethal gases may occur in upright silos at any time during filling, but the greatest danger is from 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 15-20 minutes before going into a partly filled silo. Keep the blower 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.