

Corn Silage Management

J.W. Schroeder

Extension Dairy Specialist

Silage can be made from many different crops, although the ability to make good silage is limited at times. In North Dakota, corn is a widely used crop for silage. Worldwide, corn silage is one of the most important forages used for livestock for the following reasons:

- high yields of high-energy feed per acre
- palatable, consistent feed
- can be stored directly at time of cutting when plant characteristics for storage are near ideal
- rapid harvest
- low-cost storage

Efficient utilization of silage by livestock depends on the stage of maturity at which the crop is harvested. The growth stage has a major influence on forage digestibility and the amount of a particular forage consumed by livestock. Various studies have shown that the best time to harvest a crop for silage is a compromise between high forage yield and forage digestibility. In addition, each crop will have an optimum growth stage for harvest, depending upon its individual characteristics.

Plant Composition

The composition of plants harvested for corn silage can vary depending on hybrids used and environmental conditions. Table 1 shows possible ranges for the different plant components.

The grain portion of the silage hybrid contains the most digestible energy, followed by leaves, husks, cob and stalks.

The nutrient variation in corn silage can have a significant range in values. These ranges are shown in Table 2.

Table 1. Variation in plant composition in hybrids harvested for corn silage.

Plant Part	Range Observed ¹
Grain	15-60
Leaves	15-25
Stalk	20-40
Cob	6-10
Husk	6-8

¹ Percent, dry matter basis.

Table 2. Nutrient variation in corn silage.

Nutrient	Average Value ¹	Range
Crude protein	8.0	6-17
Acid detergent fiber	28.0	20-40
Neutral detergent fiber	48.0	30-58
Total digestible nutrients	67.0	55-75
Net energy-lactation (Mcal/lb)	0.68	0.58-0.74
Calcium	0.26	0.10-0.40
Phosphorus	0.30	0.10-0.40

¹ All values are percent dry matter basis, except net energy-lactation.

References

NDSU Extension Service publication R-846 "Silage Production and Management."

Portions adapted with permission from Pioneer Forage Manual, which is no longer in print.

Management Decisions

Some of the more important management decisions that influence the quality and quantity of the crop that is harvested when corn silage is grown are:

- hybrids selected
- plant population
- fertilization
- maturity at harvest
- harvest management
- storage management

Hybrid Selection

Hybrid selection can influence corn silage in three ways:

- yield of material harvested
- grain content in the silage at harvest
- digestibility of corn silage

Yield can be greatly influenced by hybrid selection. The hybrid used for corn silage should be of the proper maturity for the area in which it is grown. If the relative maturity is too short, the total yield of the corn silage likely will be sacrificed. If the maturity rating of the hybrid is too long for the area, poor quality may result due to decreased grain content.

Moisture content at the time of harvest (too wet or too dry) also may be a problem if the proper maturity is not matched to the area. If a large acreage of corn silage is to be harvested, slight maturity variation should be considered so harvesting schedules will match the proper plant maturity at harvest.

Grain content can vary significantly due to genetic differences between hybrids with similar maturity ratings. The percent of grain can

vary from less than 20 to more than 50 percent on a dry-matter basis. Differences in stover digestibility due to genetic differences have been shown by researchers at Pioneer Hibred International, University of Georgia and Michigan State University, and in Europe.

When the effects of grain content and stover digestibility are combined, very significant differences in corn silage quality can result due to hybrid differences. Hybrid selection should be based on quality and quantity of the corn silage produced.

Ideal Silage hybrid

- Ability to produce high yields of high-quality forage
- Ability to have more than 40 percent grain on a dry-matter basis
- Must not drop or “flick” ears at harvest
- Good “stay in color”
- Resistant to lodging
- Stover that is highly digestible

Plant Population

Silage quality and yield are impacted significantly by plant population. For corn silage, plant populations usually can be increased by 10 to 15 percent over what is recommended for the dry-grain harvest. Proper plant spacing is crucial for top yields and quality, and this will maximize the production potential.

Fertilization

Proper fertilization is essential for obtaining maximum corn silage yield and nutritional value.

Fertilization rates should be determined by using yield goals

adjusted for factors such as time of application, soil type, plowed-down crops or manure that has been applied to the soil. If higher plant populations are planted for corn silage, fertilization rates should be adjusted accordingly.

Maturity at Harvest

Maturity at harvest may affect corn silage quality because it influences grain and moisture content as well as stover digestibility.

The maturity of corn silage can be determined best by the milk line location. The milk line is the interface between the liquid and solid portion of the kernel (see Figure 1). The milk line will not appear until the corn is at the dent stage of maturity. Some hybrids do not show the milk line as readily as others and the kernel may have to be cut lengthwise to determine the location. The milk line also can be determined by biting the kernel, starting with kernels from the tip.

As corn silage matures, the milk line moves down the kernel, and plant composition and energy values will change. Table 3 shows how plant composition and energy values varied in a Pioneer corn silage study when harvested at three different stages of maturity.

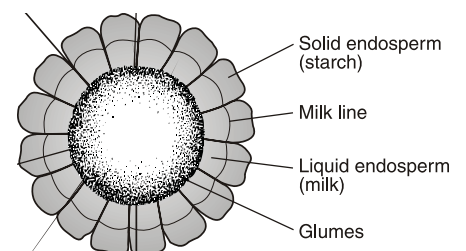


Figure 1. Cross section of the tip half of a corn cob showing milk line progression of the kernel.

Table 3. Plant composition and energy yield of whole-plant corn silage harvested at three different stages of maturity.¹

Maturity	Grain	Stover	Sugar	Starch	TDN/Acre ²
1/3 milk line	32.4	59.1	9.8	22.2	7.2
2/3 milk line	41.8	50.2	7.1	28.4	7.8
black layer	46.1	45.8	6.6	31.0	7.7

¹ Average of six hybrids, two locations.

² Tons of total digestible energy per acre, dry matter basis.

Harvest Management

Table 3 shows that while grain content was the highest at black-layer maturity, the highest energy values were at the second maturity (2/3 milk line). This is due to reduced digestibility of the stover portion of the plant with advancing maturity.

As a rule of thumb, corn silage quality will be optimum if the grain fill is allowed to occur until the milk line is one-half to two-thirds of the way down the kernel (see Figure 1). Animal studies indicate that optimum intake of corn silage also occurs at this maturity. Harvesting at this stage usually results in near optimum moisture content for storage of the corn silage.

Research at Pioneer and the University of Minnesota indicates that when the kernels are just denting (prior to milk line formation), the whole plant moisture will be 73 to 76 percent. Harvest at this maturity would result in lower grain content and loss of valuable nutrients due to runoff. When the milk line is one-half to two-thirds of the way down the kernel, the whole plant moisture will be in the range of 65 to 70 percent. This gives the best possible compromise among grain content, sugar content, stover digestibility and moisture content.

If the corn silage is to be placed in upright silos, the lower end of this moisture range should be the target moisture. When the kernels first form a black layer, the whole-plant moisture will increase harvest loss and make packing much more difficult, thus increasing storage losses (see Figure 2).

Variations from the moisture guide “rule of thumb” can occur due to hybrid, location and weather conditions. The stage of maturity and moisture content of the corn plant always should be monitored closely prior to beginning harvest.

Frosted Corn

Corn plants that have been frosted prior to harvest likely will lose some feed value because the

digestibility of dry matter, energy and protein normally are reduced. These reductions can be minimized if the crop can be harvested as soon as possible after the frost. If the frost reduces the amount of moisture in the crop below optimum levels, packing the corn silage during harvest may be more difficult and storage losses may increase. Chopping the corn to a shorter length and the addition of water should be considered.

Storage Management

Once the proper maturity and moisture content have been determined for harvest, the primary management concerns are to harvest the crop as quickly as possible, avoid runoff, and store and treat the corn silage in a manner that eliminates and excludes as much oxygen as possible. These steps will ensure a fast, efficient fermentation with minimum losses during ensiling, storage and feed-out.

Harvest and storage management decisions are critical to producing the best quality corn silage possible.

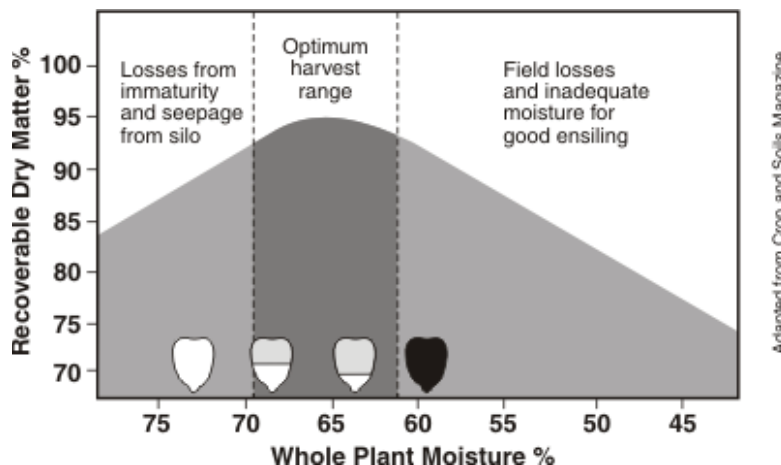


Figure 2. Kernel milk line (maturity) showing expected yields.

Mechanized Processing

Research at Washington State University and the University of Idaho have established that mechanical processing, formerly referred to as kernel processing, not only affects the kernels but also the fiber part of the plant. As a result, a number of livestock producers are processing their corn silage. Some of the mechanical silage processors are installed on the field chopper and some are at the storage site, where the corn silage may be rolled as it is unloaded for feeding.

Mechanically processing the corn kernels by scratching, smashing (rolling) or recutting increases the exposed surface area of the kernel, resulting in improved digestibility. Processing corn silage also has been found to increase the digestibility of the fiber of the corn stover. Processing breaks the ear into smaller particles, reducing the sorting of the ration and increasing the intake of this valuable fiber source.

Some newer, high-yielding corn varieties have genetically harder kernels. This resulted as corn hybrids were developed for quicker dry-down characteristics to reduce drying costs. The result is a shorter period of time for harvesting corn silage at the proper stage and before the kernel becomes too hard.

In addition, environmental conditions, especially drought, also can result in a harder corn kernel that is more difficult for the cow to digest. The end result is corn kernels that pass through the gastro-intestinal tract undigested.

Pre-ensiled processing of corn silage has been shown to offer several other benefits, including:

- Faster rate of silage fermentation
- More densely packed material in the silo
- Decreased dry-matter loss in silage storage
- Increased the effectiveness of inoculants

Research at the USDA Forage Research Center supports that mechanical processing can improve feed efficiency and milk production. However, the equipment is expensive and may not pay for itself in a smaller operation. Larger farms are able to capitalize on new technology because of the volume handled and size of their enterprise. Small operations need to look at custom operators for efficiency and eliminating the high cost of purchasing large equipment.

For limited use, hiring a custom corn harvester equipped with a processing unit would be more economical. The unit alone can cost \$10,500, so the owner needs to feed a large amount of corn silage or to custom harvest many acres to justify the investment.

The cost for custom harvesting with mechanical processing typically will add about \$1 per ton extra harvesting cost, which is well worth the cost in net returns in higher milk production.

Most corn is grown for grain. New varieties are developed genetically toward faster drying down time in the field, which is opposite the characteristic best-suited for corn harvested as silage. Most corn varieties planted today would benefit by processing when harvested as corn silage, especially if the kernels are hard, flinty or droughty, or if the corn kernel is in the black-layer stage of maturity. The payoff is about 300 pounds of additional milk per year per cow.

Other publications in the Quality Forage series

- ▶ AS1250 "Forage Nutrition for Ruminants"
- ▶ AS1251 "Interpreting Composition and Determining Market Value"
- ▶ AS1252 "Haylage and Other Fermented Forages"
- ▶ AS1254 "Silage Fermentation and Preservation"
- ▶ AS1255 "Storage, Sampling and Measuring"
- ▶ AS1256 "Stressed or Damaged Crops"

For more information on this and other topics, see www.ag.ndsu.edu

NDSU encourages you to use and share this content, but please do so under the conditions of our Creative Commons license.

You may copy, distribute, transmit and adapt this work as long as you give full attribution, don't use the work for commercial purposes and share your resulting work similarly. For more information, visit www.ag.ndsu.edu/agcomm/creative-commons.

North Dakota State University does not discriminate on the basis of age, color, disability, gender expression/identity, genetic information, marital status, national origin, public assistance status, sex, sexual orientation, status as a U.S. veteran, race or religion. Direct inquiries to the Vice President for Equity, Diversity and Global Outreach, 205 Old Main, (701) 231-7708.

County Commissions, NDSU and U.S. Department of Agriculture Cooperating.

This publication will be made available in alternative formats for people with disabilities upon request, (701) 231-7881.

400-1-06; 200-7-13