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Harvesting Corn Silage by Plant Moisture

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Introduction

Corn must be ensiled at the appropriate moisture level to get proper fermentation for preservation and optimal nutritional value. Deciding when to harvest is based on grain maturity, whole-plant fiber levels and whole-plant moisture. Harvested too wet, silage loses soluble nitrogen and carbohydrates to leakage. On the other hand, silage that is chopped too dry may lose leaves and won't pack properly, setting the stage for inefficient fermentation.

Harvesting corn silage when the entire plant is between 60 and 70 percent moisture will provide the best combination of dry matter yield and digestibility. It is also the moisture level where the best silage fermentation occurs. This level varies slightly depending on the type of silage storage unit used. The recommended guidelines are listed in Table 1.

Table 1. Silo types

	Percent Moisture
Horizontal bunker silo	65% - 70%
Bag silo	60% - 70%
Upright concrete stave	63% - 68%
Upright oxygen limiting	55% - 60%

Adapted from: (eXtension, 2009)

Methods commonly used as indicators to determine optimal whole plant moisture levels are listed below.

Black Layer Method

Physiological maturity occurs when the corn kernel is fully formed and is no longer taking sustenance from the plant. At this stage a "black layer" of tissue forms near the tip of the kernel. It can be observed by either cutting the kernel lengthwise in half of by breaking the tip of the kernel off with a knife or thumb nail. When the black layer appears the kernel has reached its maximum dry weight. The black layer occurs first in the kernels near the tip of the ear and last in the kernels at the base of the ear. By the time the kernels in the center of the ear have developed a black layer the whole corn plant is generally between 55 and 60 percent moisture.[1] Waiting for the black layer to form before chopping was promoted as the way to get maximum grain production until the early 80s when evidence suggested the relationship between whole plant moisture and black layer was too variable. Many modern corn hybrids have the "stay green" trait where the kernels are dented and black layered, though the stover remains green. As such, the black layer method is no longer considered a reliable method for determining harvest dates for corn silage.

Milkline Method

The milkline is often used as a preliminary method for estimating corn moisture. On an individual corn kernel, the milkline is the interface between the solid and liquid portions. This line appears about the time the kernel starts to dent and will move from the crown (top) of the kernel toward its base as it matures and dries (Figure 1) When the milk-line is gone the crop is close to physiological maturity.

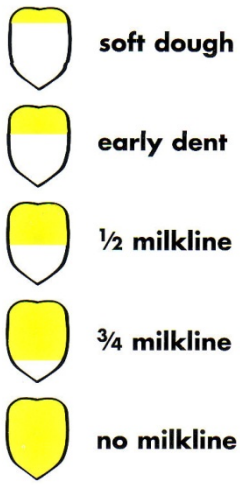
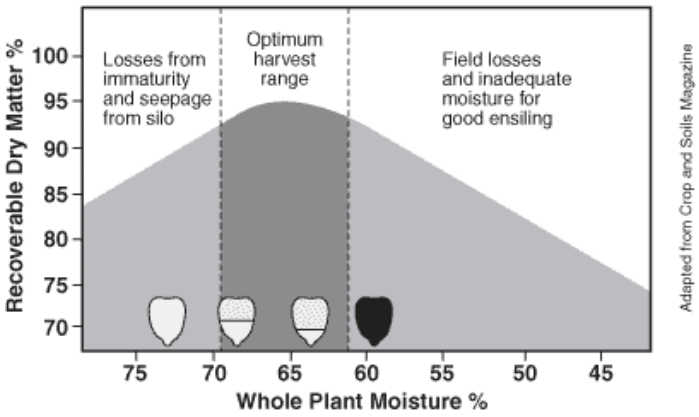


Figure 1. Milkline

To observe the milkline, break a corn cob in half and look at the cross section of the top half of the ear. (Figure 2) Now run a ballpoint pen from the top of the kernel to the bottom to find the milkline. As the pen point crosses from the solid portion of the kernel to the liquid part it will penetrate the seed coat and some of the milky endosperm will come out.

Figure 2. Corn cob at about one half milkline

Agronomists teach that when the milkline is half way down the kernel, silage moisture will be approximately 68 percent, a good moisture level for packing and fermentation. By the time it gets three fourths of the way down the kernel the whole plant moisture will have dropped to around 64 percent, the dry end of the recommended harvest window. The optimum stage for harvest is from one fourth to two thirds milkline.[2]



Calendar Method

Growers may use Table 2 to determine corn growth and development from tassel to physiological maturity. Growing degree units (GDU's) have an obvious impact on how fast maturity occurs.

Table 2. Corn growth and development from tassel to physiological maturity				
Growth Stage	Growth Stage Description	Days	Accumulated days from tassel (VT)*	GDU's per stage**
VT	Tassel - Tassel completely visible, silks not	4.5	4	100
R1	Silking - Silks emerged, tassel shedding pollen	4.5	9	100
	Silks brown 75% of silks purple to brown	5.7	14	125
	Silks brown, no fluid in kernels	4.5	19	100
R2	Blister - Kernels are water blisters	4.5	23	100
	Kernels changing color from white to yellow	4.5	28	100
R3	Milk - Milky fluid in kernel, no solids	4.5	32	100
78% wpm***	Kernels at base of ear contain semi-solids	4.5	37	100
R4 75% wpm	Soft Dough - Most kernels contain semi-solid material. Kernels at base of ear beginning to dent	4.5	42	100
72% wpm	Hard Dough - 90% kernels dented - Kernels are still yellow	4.5	46	100
R5 70% wpm	Dent - Nearly all kernels in hard dent - milk line is beginning to show, husks browning	5.7	52	125
68% wpm	1/4 milk line - All kernels in hard dent	5.7	57	125
65% wpm	1/2 milk line	5.7	63	125
R6 62% wpm	Physiological Maturity - Mature, black layer formed, kernel moisture 25% to 35%	5.7	69	125

*VT is 'visible tassels'
**GDU is Growing Degree Units (Max Temp+Min Temp/2) minus 50=GDU for a 24 hour period
***wpm is whole plant moisture
Reference: 2010 Silage-Specific Product and Management Guide, Dow AgroSciences

Electronic Methods

Two commonly accepted tools for carefully measuring whole plant moisture levels are the Koster tester and the microwave oven. The Koster moisture tester is a portable, forced air electric drying unit. Koster samples take about one-half hour to dry for an accurate reading. Forage moisture can also be determination accurately and relatively easily with a microwave oven by following the steps listed below. The drying time with microwave ovens is usually 8 to 20 minutes.

1. Weigh a 100-gram sample of chopped silage on a paper plate, excluding the weight of the plate. Duplicate samples are recommended for a more accurate measurement. Follow this procedure one sample at a time.
2. Spread the silage evenly over the plate and place it in the microwave. Place an 8-ounce glass three-quarters full of water in the microwave's back corner to prevent igniting the sample.
3. Heat the sample for 3 minutes initially, on high power.
4. Remove the sample from the microwave, weigh and record the weight. Stir the sample and return it to the microwave.
5. Repeat Steps 3 and 4, but use 1-minute time intervals. To prevent burning, use 30-second intervals as sample approaches dryness. Continue drying and weighing until the weight changes by less than 1 gram (or until the weight remains the same).
6. The final dry weight, minus the plate, is the dry matter percentage. To determine moisture content, take the final dry weight, minus the paper plate, and subtract from 100.
7. Repeat Steps 1 through 6 with the duplicate silage sample and average the results.
8. 50 grams may be used if there are many samples to determine moistures, but results must be multiplied by two to calculate accurate percentage. Accuracy is even more critical if a lower weight is used.

When using these electronic methods, even under the best of conditions, there will be 1 to 2 percent residual moisture in the dried sample. If a subsample of freshly chopped corn samples is sealed, kept cool and taken to an official laboratory for dry matter evaluation, either by oven or NIR, harvesters will know how far off they are and future farmstead moisture determinations can be adjusted accordingly.

Grab Test Method

Another procedure that can be used when more accurate methods are not utilized is the "grab test." This is accomplished by using a forage chopper, heavy knife or yard chipper to chop a few plants from the field, avoiding headlands. Tightly squeeze a handful of finely cut material for 90 seconds, release the grip, and note the condition of the ball as listed in Table 3.

Table 3. Condition of the forage ball

	Percent Moisture
Ball holds its shape and considerable free juice	over 75%
Ball holds its shape with very little free juice	70% - 75%
Ball falls apart slowly with no free juice	60% - 70%
Ball falls apart rapidly	less than 60%

Reference: Gary Bates, "Corn Silage" Agricultural Extension Service, The University of Tennessee. SP434-D.

Few growers can harvest all of their corn silage on the single day, which optimizes yield and nutrition. As such, growers should start chopping at the low end of the acceptable harvest window and plan to be finished before the corn becomes too dry. Some growers wisely plant hybrids with varying days to maturity, spreading their harvest window over a longer period. Understanding silage performance as maturity advances increases the likelihood of maximizing milk, meat and money per acre.

References

[1] Roger O. Ahsley, "Corn Maturity and Ensiling Corn" http://www.agndsu.nodak.edu/dickinso/agronomt/cornmaturity.htm

[2] M.A. Bal, J. G. Coors, and R. D. Shaver. 1997. "Impact of the Maturity of Corn for Use as Silage in the Diets of Dairy Cows on Intake, Digestion, and Milk Production," J Dairy Sci 80:2497-2503. Page 2497.

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