

Special Issue

October 8, 2009

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2009 Post-Harvest Tips for Later Maturing Corn . . . . . 1

This is a special issue of the NDSU Crop and Pest Report to address some of the post-harvest concerns for corn. There will not be a printed version; however, it will be posted on our website:

<http://www.ag.ndsu.nodak.edu/aginfo/entomology/ndsucpr>



**2009 POST-HARVEST TIPS FOR LATER MATURING CORN**

**Corn Maturity**

Progression to maturity is very slow in October even if there is not a killing frost. The average amount of growing degree-days, GDDs, during the first two weeks of October is about 100. In 2008, there were about 70-80 GDDs during the first two weeks of October. The average amount of growing degree-days for October 11-31 is only about 50 GDDs. If the corn has just reached full dent but not full maturity, a small reduction in test weight and yield might be expected for the corn this year.

The following table summarizes information from various sources on corn development.

Stage	Days to Maturity	GDDs until Mature	Yield Loss (%)	Test Weight (lbs/bu.)	Grain Moisture Content (%)
Dough	30-40	600-700	50-60	35-40	60-80
Early Dent	20-25	450-550	25-40	45-50	50-55
Full Dent	12-17	250-400	10-20	50-53	35-45
Half Milk Line	10-15	150-300	5-10	54-55	35-40
Mature	0	0	0	56	25-35

\*GDD needed varies with corn RM and hybrid

**Field Drying**

The amount of drying in the field depends on parameters such as corn maturity, hybrid, and moisture content, air temperature and relative humidity, solar radiation, and wind speed. The moisture content to which corn will dry is determined by the corn's equilibrium moisture content, EMC, which is based on air temperature and relative humidity. Corn growing degree-days have been used to predict the rate of field drying. Another predictor of the drying rate is potential evapotranspiration, PET, which is based on parameters similar to those that affect drying. Values for PET calculated by the North Dakota Agricultural Weather Network for 2008 are shown in the following table. There appears to be a good correlation between PET and field drying experience. The table shows these EMC, GDD, PET values and the estimated percentage points of field drying for each month.

“Estimated” Corn Field Drying

Month	EMC (%)	GDD	PET (in.)	Estimated Drying (%-pt.)	
				Month	Week
Sep	15	250-350	4.0-5.0	18	4.5
Oct	16	100-125	2.8-3.5	11-12	2.5
Nov	19	20-30	0.8-1.2	4-5	1
Dec	20	0	0.5-0.8	2	0.5
Jan	21	0	0.5-0.8	2	0.5
Feb	21	0	0.5-0.9	3	0.8
Mar	19	0	1.3-1.6	5	1
Apr	16	50-90	3.2-4.5	16	4
May	14	200-300	6.5-8.5	30	7

PET=Potential Evapotranspiration (NDAWN, Weather, Total PET, Estimate: 1-inch = 4% drying)

EMC=equilibrium moisture content, GDD=growing degree-days,

%-pt. - percentage point of moisture reduction, for example from 20% to 15% are 5%-pts.

Standing corn in the field may dry about 0.3 to 0.4 percentage points per day during October, assuming normal weather conditions, and 0.15 to 0.2 per day or less during November. Corn at 35% moisture content on October 11 might be expected to dry to about 27% by November 1 and about 22% by December 1. Therefore, corn moisture content at harvest will likely be in the mid-20% range again this year.

Immature corn dries more slowly in the field than mature corn. Frosted high moisture corn can cause molds on the stalk.

Field drying is normally more economical until mid to late October and mechanical high temperature drying is normally more economical after then.

Field drying is extremely slow during winter months and corn will only dry to about 20% moisture content based on the equilibrium moisture content for average monthly air temperature and relative humidity conditions. Corn in the field over winter in 2008-2009 dried from 25 - 30% moisture in November to 17 -20% when harvested in February and early March. Corn losses were generally small if the corn stalk was strong in November. There are numerous reports of weak corn stalks this year, so field losses might be much greater this year than last year.

Examine the stalks and push on them to determine stalk condition, before deciding to leave corn stand over winter. Accumulated snow and cover on the snow and ground from the corn resulted in wet fields in the spring.

**Postharvest Management of High Moisture Corn**

Corn at moisture contents exceeding about 23% should not be stored in a grain bin because the kernels may freeze together and also may deform and bind together. The corn may not flow from the bin for unloading. Corn above this moisture content should be placed so it can be unloaded with a front-end loader or something else that can mechanically dislodge the corn.

It is critical to provide aeration to keep the corn cool. Wet corn will deteriorate rapidly unless kept cool. Corn will deteriorate even with airflow, but without airflow through the corn it will increase in temperature resulting in rapid deterioration.

Condensation and icing occurs on bin vents at temperatures near or below freezing, so leave bin covers open to serve as a safety opening when operating fans near or below freezing temperature. There were numerous reports last year of bin vents freezing over and the fan pushing the roof up and damaging the bin roof.

"Approximate" Allowable Storage Time (Days) for Cereal Grains

M.C. (%)	Temperature (°F)					
	30°	40°	50°	60°	70°	80°
14	*	*	*	*	200	140
15	*	*	*	240	125	701
16	*	*	230	120	70	40
17	*	280	130	75	45	20
18	*	200	90	50	30	15
19	*	140	70	35	20	10
20	*	90	50	25	14	7
22	190	60	30	15	8	3
24	130	40	15	10	6	2
26	90	35	12	8	5	2
28	70	30	10	7	4	2
30	60	25	5	5	3	1

Based on composite of 0.5 percent maximum dry matter loss calculated on the basis of USDA research at Iowa State University; Transactions of ASAE 3330337, 1972; and "Unheated Air Drying," Manitoba Agriculture Agdex 732-1, rev. 1986.

\* Approximate allowable storage time exceeds 300 days.

**High Moisture Corn Storage by Ensiling**

Shelled corn should be at 25 to 35% moisture for anaerobic (without oxygen) high moisture storage in silos or silo bags. Any tears in the plastic bag must be promptly repaired to minimize storage losses. Whole shelled corn can be stored in oxygen-limiting silos, but a medium grind is needed for proper packing in horizontal or conventional upright silos. A bunker needs to be air tight - covered with plastic on top and sides, sealed at seams, etc. In addition, it needs to be managed to seal any punctures in the plastic that occur during the storage period. Exposure to air will result in spoilage and loss. Wet grain exerts more pressure on the silo than corn silage, so conventional concrete stave silos may require additional hoops or the silo must not be completely filled. Corn at moisture contents below 25% will not ensile, so it will need to be dried for storage. If oxygen is not adequately removed as the corn ensiles, heating and severe deterioration will occur.

**Natural Air and Low Temperature Corn Drying**

Corn above 21% moisture should not be dried using natural air and low temperature drying to minimize corn spoilage during drying. An airflow rate of 1.0 to 1.25 cfm/bu is recommended to reduce drying time. Because the drying capacity is extremely poor at temperatures below 35 to 40 degrees, little drying may be possible during the fall using a natural air system. Cool the corn to 20 to 25 degrees for winter storage and start drying in early April. Adding heat does not permit drying wetter corn and only slightly increases drying speed. The primary effect of adding heat is to reduce the corn moisture content. Natural air drying in the spring is the most energy and cost effective method of drying. Corn depth should be limited to about 20 to 22 feet to obtain the desired airflow rate for drying. Turn fans off during extended rain, fog or snow to minimize the amount of moisture moved into the bin by the fan.

**High Temperature Drying**

Using the maximum drying temperature that will not damage the corn increases the dryer capacity and reduces energy consumption. The amount of energy required to remove a pound of water is about 20% less using a drying air temperature of 200°F than at 150°F. Typical recommended drying temperature is about 210 °F. Be aware that high drying temperatures may result in a lower final test weight and increased breakage susceptibility. In addition, as the drying time increases with high moisture corn, it becomes more susceptible to browning. Dryer temperatures needed to be reduced below 200°F in 2008, to minimize the corn kernel damage.

Housekeeping during drying was critical during 2008 due to condensation occurring on the dryer creating a wet surface for debris to accumulate. The debris sometimes reduced airflow through the dryer reducing drying capacity and creating a fire hazard.

**In-Storage Cooling**

Use in-storage cooling instead of in-dryer cooling to boost capacity of high-temperature dryers. Cooling corn slowly in a bin rather than in the high temperature dryer will also reduce the potential for stress cracks in the kernels.

In-storage cooling requires a positive-pressure, airflow rate of about 0.20 cfm/bu or 12 cfm/bu-hr of fill rate. Cooling should be started immediately when corn is placed in the bin from the dryer. Dryer capacity is increased 20 to 40% and about one percentage point of moisture is removed during corn cooling. Condensation problems can be reduced by cooling the corn in the dryer to about 90 degrees before placing it in storage. There is more condensation at cold outdoor temperatures, such as occurred last year, than when outdoor temperatures are warmer.

**Dryeration**

Dryeration will increase the dryer capacity about 50 to 75%; reduce energy used by about 25% and remove about 2 to 2.5 points of moisture. (0.25% for each 10 degrees the corn is cooled.) With dryeration, hot corn from the dryer is placed in a dryeration bin with a perforated floor, allowed to steep for 4 to 6 hours without airflow, cooled, and then moved to a storage bin. There will be a tremendous amount of condensation during the steeping and cooling process, so the corn must be moved to a different bin for storage or spoilage will occur along the bin wall and on the top grain surface.

**Dryer Energy Efficiency**

A dryer that captures the heat from cooling the dry corn and a portion of the air from the final drying portion of the dryer can reduce the energy used to dry the corn by about 20% or more depending on outdoor temperature. Newer dryers typically have incorporated features to make them more energy efficient than previous dryers.

**Estimating High Temperature Drying Cost**

Propane cost for high temperature drying corn can be estimated using the following formula. Cost/bu. - pt. =  $0.022 \times \text{propane price/gal.}$  For example, the drying cost is \$0.022/ bu.-pt. if the cost of propane is \$1.00,  $0.022 \times \$1.00$ . It will cost about \$26.00 for propane to remove 10 percentage points of moisture from 120 bushels of corn using \$1.00 propane.

**Estimating Drying Fuel Requirement**

The estimated quantity of propane needed to dry is 0.02 gallons per bushel per point of moisture removed. For example, 24 gallons of propane is needed to dry 120 bushels of corn from 25% to 15%. ( $0.02 \times 120 \text{ bu.} \times 10 \text{ pts.}$ ) This is based on 0.72 pounds of water being removed per point of moisture per bushel, 2,500 Btu of heat required to remove a pound of water in a high temperature dryer, and a propane heat content of 91,500 Btu/gallon.

**Moisture Shrink**

Moisture shrink is the reduction in weight as the grain is dried. The moisture shrink (%) =  $[(Mo-Mf) / (100-Mf)] \times 100$ . Mo=Original Moisture Content, Mf=Final Moisture Content. The moisture shrink drying corn from 25% to 15% is  $[(25-15) / (100-15)] \times 100 = 11.76\%$

Moisture shrink factor is the reduction in weight as the grain is dried one percentage point. Moisture Shrink Factor =  $100 \div (100 - \text{final moisture content})$ . The shrink factor drying corn to 15.5% is 1.1834. The moisture shrink drying corn from 20.5 to 15.5 would be  $5 \times 1.1834 = 5.92\%$ .

**Obtaining an Accurate Moisture Content Measurement**

Moisture meters will not provide accurate readings on corn coming from a high temperature dryer. The error will vary depending on the amount of moisture removed and the drying temperature, but the meter reading may be about 2% lower than true moisture. Check the moisture of a sample, place the sample in a closed container for about 12 hours, and then check the moisture content again to determine the amount of error.

Moisture meter errors increase as corn moisture contents increase, so readings above 25% should only be considered estimates.

In addition, moisture meters are affected by grain temperature. If the meter does not automatically measure the grain temperature and adjust the value, then it must be done manually. Even if the meter does it automatically, it is recommended to cool a sample in a sealed container to room temperature before measuring the moisture content. Then compare the moisture content of the room temperature sample to the initial sample to verify that the adjustment is done accurately.

Moisture meters normally are not accurate when grain temperatures are below about 40 degrees. Place the corn sample in a plastic bag or other sealed container, warm it to room temperature, and then measure the moisture content.

**Corn Test Weight**

Normally, corn test weight increases about 0.25 pound for each point of moisture removal during high temperature drying. However, the increase in test weight is affected by the amount of mechanical damage during harvest and the gentleness of the drying. Due to the high mechanical damage involved with harvesting 25% to 30% moisture corn and high drying temperatures used in 2008, frequently there was no increase in test weight during drying. There will be little or no increase in test weight on immature or frost-damaged corn.

**Corn Storage**

More fines are produced when corn is wet, because more aggressive shelling is required, which causes more kernel cracking and breaking. There is also more potential for stress cracks in kernels during drying, which leads to more breakage potential during handling. In addition, immature corn contains more small and shriveled kernels. Fines, materials or broken kernels cause storage problems because they spoil faster than whole kernels, they have high airflow resistance, and they accumulate in high concentrations under the fill hole unless a spreader or distributor is used. Preferably, the corn should be screen-cleaned before binning to remove fine material, cob pieces, and broken kernels.

Corn with damage to the seed coat and immature corn has a shorter storage life than mature corn. Therefore, cooling the grain in storage to about 20 to 25 degrees for winter storage is more important than for mature corn. It is recommended to dry the corn a percentage point lower in moisture content. More frequent checking of the storage is also recommended, and immature or damaged corn is not recommended for long-term storage.

**Safety**

Ice accumulation on fans leads to imbalance and vibration. Fan disintegration occurred in 2008-09 due to this problem. Monitor fans for ice accumulation and remove the ice if it is observed. Bridging of corn in a bin transfers more of the load to the bin wall that may lead to bin failure. Follow recommended storage management to minimize the potential for crusting or bridging and watch for the grain flow when unloading. Never enter a bin while unloading grain. Also, do not enter a bin to break up grain bridging. Two people in this region lost their lives in 2008-09 due to grain entrapment, and several more narrowly escaped.

**For more information do an internet search for NDSU corn drying.**

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Non-Profit Org.  
U.S. Postage  
**Paid**  
Permit No. 818  
Fargo, N.D.

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