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Corn Drying and Storage 2014

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Field Drying

Standing corn in the field may dry about 0.3 to 0.5 percentage points per day during October, and 0.15 to 0.2 per day or less during November, assuming normal weather conditions. Field drying is normally more economical until mid-October and mechanical high temperature drying is normally more economical after then. If corn has a moisture content of 32% on October 1, it will probably only dry to about 22% moisture by November 1 assuming normal North Dakota climatic conditions.

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. A predictor of the drying rate might be 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 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

EMC=equilibrium moisture content, GDD=growing degree-days,
PET=Potential Evapotranspiration

(NDAWN, Weather, Total PET, Estimate: 1-inch \approx 4% drying)

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

The following table provides field drying rates for corn in Minnesota.

Field drying rates for corn in Minnesota

Date	Grain moisture loss (% per day)
September 15-25	0.75-1.00
September 26-October 5	0.50-0.75
October 6-15	0.25-0.50
October 16-31	0.00-0.33
After October 31	>very little

Source: Hicks (2004)

<http://www.extension.umn.edu/cropenews/2008/08MNCN26.html>

Immature, Frosted Corn

Yield potential for corn frozen during the milk stage is low. Ears are difficult to pick and shell, kernel tips may stay on the cobs, and grain will be very chaffy. Although corn will eventually dry to acceptable harvest moisture, it will take at least a week longer than mature grain. Ear molds will likely develop if warm ambient temperatures follow the frost. The only means of stopping mold growth are drying the grain or ensiling.

Harvest vs. Leave it in the Field

Assure corn stalks and shanks are strong if considering leaving very high moisture corn in the field. Field losses can range from minor to severe. To compare the costs of drying versus losses associated with leaving the corn in the field. The propane cost can be estimated by multiplying the propane price per gallon by 0.02. For example the cost to remove 10 points of moisture using \$2.00 propane is \$0.40. Dividing the propane cost by the corn price provides the percentage of corn losses that will equal the drying cost. ($\$0.40/\$3.00=0.13$ or 13%) Also, verify the impact on insurance of leaving the corn in the field.

Postharvest Management of 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 and the air pressure from the fan pushing on the roof damages the bin roof, so leave bin covers open to serve as a safety opening when operating fans near or below freezing temperature.

"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

Shelled corn should be at 25 to 30% moisture for anaerobic (without oxygen) high moisture storage (ensiling) 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.

Storage in a Poly Bag

Even though the bag is sealed, it does not prevent mold growth or insect infestations. At moisture contents exceeding about 25% ensiling may occur at temperatures above freezing and prevent the corn from being dried and sold in the general market. Grain temperature in the bag will follow average outdoor temperatures, unless respiration heating causes the temperature to increase. Corn needs to be at an appropriate moisture content and temperature to limit the potential for heating and grain quality losses during storage. Corn above 24% moisture should be placed in the bags when average outdoor temperatures are staying near or below freezing and the corn should be dried by early February before outdoor and grain temperatures increase above freezing and permit spoilage. Corn at moisture contents up to 24% should be dried by early March before grain temperature reaches 40 degrees. Corn stored during late spring and summer needs to be below 14% moisture. Select an elevated well drained location for the bags and run

the bags north and south so solar heating is similar on both sides of the bag. Wildlife can puncture the bags creating an entrance for moisture and releasing the grain smell which attracts more wildlife. Monitor the grain temperature at several locations in the bags.

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 temperatures are 210°F to 230 °F. Be aware that excessively 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.

Research indicates that exposure to drying air temperatures above 200 degrees for time periods in excess of 2 hours will likely result in some degree of browning. Dryer temperatures may need to be limited to prevent scorching or browning. The darkening during drying can also be due to sugar in the kernels that becomes caramelized, which is a sign of incomplete development.

Propane cost for high temperature drying corn can be estimated using the following formula. Cost/bu. – pt. = 0.02 x propane price/gal. For example, the drying cost is \$0.04/ bu.-pt. if the cost of propane is \$2.00, 0.02 x \$2.00. It will cost about \$48.00 for propane to remove 10 percentage points of moisture from 120 bushels of corn using \$2.00 propane.

For corn valued at \$3.00 per bushel, it is equivalent to 16 bushels per acre or a 13% loss for a yield of 120 bushels per acre. This expense needs to be compared to the potential loss and problems associated with leaving corn stand in the field over winter.

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 x 120 bu. x 10 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 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.

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 allow a sample in a sealed container to reach 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 maturity also affects moisture meters, so there may be an error in measuring the moisture content of immature corn.

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 typically used on high moisture corn, frequently there is 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 high moisture corn is harvested, 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 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 which has caused fans to disintegrate. 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. Several lives have been lost due to grain engulfment and there have been numerous entrapments where people needed to be rescued.

Working with high moisture corn can be hazardous. Become informed of the hazards and recommended safety practices. Do not become a fatality.

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