GRAIN QUALITY Task Force

Fact Sheet # 17
March 17, 1994
Purdue University

Rewarming "Supercold" Grain

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After an excellent fall harvest and a cold winter, stored grain quality should be high in Indiana. However, the cold winter weather enticed many farmers and elevator operators to aerate corn with subzero temperatures in order to "freeze" it and improve its keeping quality into the spring and summer. Although aerating with such low temperatures does not cause any known physical damage, it does not freeze the corn nor does it improve keeping quality significantly. Below 18% moisture, the water contained in individual kernels is bound in such a way that it does not crystalize into ice (freeze). However, "supercold" corn can be a problem if it is to be carried into warmer weather.

Normally, cooling grain to 30 - 35˚F as soon after binning as possible controls most of the potential spoilage agents such as molds and insects. As outside temperatures rise in the spring, the outer grain layers and the top and bottom of the pile begin to warm. If the temperature difference between the pile and the outside air is too large, moisture may begin to migrate in the bin and create spoilage problems. Even more importantly, as grain is moved for feed or sale, condensation on supercold kernels may cause mold spoilage.

To assess the stored grain management strategies for this spring, farmers and elevator managers need to consider several points.

Grain Below 25˚F ("Supercold" Grain)

Corn that has been cooled to such low temperatures should be rewarmed at this time to reduce the extreme temperature difference that will otherwise develop between the pile and the average outside temperature. Start warming the grain as soon as air temperatures are about 10˚F higher than the average grain temperature.

If a farmer or elevator manager customarily does not rewarm their grain in the spring, they usually assume grain temperatures of 30 - 40˚F in the bin after winter storage. Thus, grain at temperatures of 20˚F or less should be brought into this range to avoid potential problems. Currently, night time ambient temperatures are still low enough to achieve this. Later in the spring this will no longer be an option.

If a farmer or elevator manager customarily rewarms their grain into the 50 - 60˚F range for spring and summer storage, they should begin to rewarm their "supercold" grain now as well. Outside temperatures in the 40 - 50˚F range will minimize condensation of moisture and subsequent mold spoilage on the supercold kernels as the grain is rewarmed. Proper warming will also thaw out any grain that may actually have frozen into clumps because of surface moisture. Frozen clumps interfere with aeration and handling. During rewarming it is especially important that the fan be operated continuously and the warming front forced all the way through the pile.

Cold and Dry Grain Marketed Before July 1

Grain that is cold (30 - 35˚F) and dry (14 - 15%), and is moved out of storage before summer does not need to be rewarmed in the spring (except for "supercold" corn as mentioned above!). Although the grain will warm along the outer layers and on the top and bottom of the pile during the spring, the bulk of the grain will remain cool. To prevent accelerated warming of the grain bulk, a good strategy is to cover the fan intake to avoid the natural “chimney” effect in which the cold air is sucked out through the fan opening and the warm air in through the roof vents. Covering may also prevent rodent and pest access. If an automatic aeration controller is used, it may be necessary to disconnect the fan from the controller to make sure it is not inadvertently turned on.

Holding Grain Past July 1

If grain will be held into the summer, the temperature in the grain mass should be raised to 50 - 60˚F by mid-spring. The fan should be operated as soon as the average outdoor temperature is 10 - 15˚F above the average grain temperature. Always run the fan continuously to complete a warming cycle and force the warming front through the entire grain mass. This will prevent deposit of moisture in the grain pile, which encourages spoilage.

Several warming cycles may need to be repeated until the average grain temperature reaches 50 - 60˚F. If an automatic aeration controller is used to manage the grain temperatures, it may be advisable to set the operating window wide enough to prevent too many on-off cycles and to assure adequate operating times for rewarming the grain.

Estimating Warming Times

The approximate grain warming times depend on the airflow rate through the grain. An aeration fan is usually sized for about 1/10 cfm/bu, while an in-bin drying fan is usually sized for 1 cfm/bu. It is very important to recognize the difference in order to operate the fans long enough to move the warming front completely through the bulk, and yet not so long as to waste electricity. The following table summarizes the approximate times for the spring rewarming cycle for a range of common airflow rates.

Airflow rate, cfm/bu	Warming time, hours
1/20	240
1/10	120
1/4	48
1/2	24
3/4	16
1	12
1.5	8

If air is pushed through the grain, temperatures about 1 foot below the upper surface should be checked in several locations to confirm that the warming front has moved completely through before the fan is shut off. If air is pulled through the grain, the air temperature should be measured in the duct before it is exhausted by the fan.

Incomplete Low Temperature Bin Drying

If natural air drying was used last fall, but drying was not completed before the winter, the fans need to be run soon. Generally, the moisture content in stored grain should be reduced below 16% before April 1 in Central Indiana; in Southern Indiana this should be accomplished 1-2 weeks earlier, and in Northern Indiana it can be 1-2 weeks later. In a properly equipped drying bin the airflow rate is at least 1.0 cfm/bu.

The fan should be run continuously when the outdoor temperatures average 40 - 45˚F until the top layer of grain is below 16%. Because overdrying is difficult to avoid in the spring, the average moisture content of the grain will likely be 13-14%. If grain is moved out of the bin on a regular basis, the higher moisture top layers will likely blend out before significant spoilage may occur during warmer weather. If only aeration fans are available the airflow rates are generally 0.1 cfm/bu, and drying should be completed by moving the grain through a high-temperature dryer (unless the grain will be marketed soon).

Other Considerations

This is also a good time of the year to level peaked grain in storage bins, if this was not done last fall or winter. Peaking makes it difficult and dangerous to enter the bin for regular monitoring. Drawing a core, or levelling the grain by hand will improve airflow through the center. Also, probing and sampling are made easier and safer. During the spring storage period, quality-conscious grain managers switch from bi-weekly to weekly grain inspections. Checking a grain bin routinely for temperature, moisture, and pests prevents major headaches later on.

If unsure about whether the grain in a bin is in good enough condition to make it through the spring, the fan should be operated on a cold day and the exhaust air checked for odors or “steam”. A musty smell, a vapor (steam) plume, or condensation on the underside of the roof indicate that the grain is heating in some parts of the bin. Remember that whenever there are serious signs of grain heating (“hot spots”), no matter what the season or the weather, run the fan continuously. Also, feed or sell such low quality grain as quickly as possible. Grain quality never improves during storage!

corn cover the perforated floor. Cooling occurs over about 48 hours with ambient air at a full bin airflow rate of 0.5 - 1.0 cfm/bu. Cooling the hot corn too slowly because of undersized fan capacity can lead to spoilage. Also, condensation can become a storage problem because the corn remains in the bin and wetter kernels are not remixed.

High-Low Temperature (2-stage) Drying - High temperature drying followed by transferring hot grain at 19-23% moisture content into a natural air drying bin appears to be a little known practice. This two-stage drying operation reduces fuel costs and increases drying capacity more than any other combination drying operation. According to research conducted in Minnesota, total fuel and electric energy consumption can be reduced by 40% to 60% for corn with initial moisture contents of 24% to 28%.

The hot corn is cooled in the bin as the low temperature drying front is started. Cooling will remove about 1 point of moisture. Sizing the fans to the proper airflow and operating the fans continuously until the top layer drops below 18% moisture and 35^{o}F is critical (see Table 1).

Table 1. Recommended airflow rates for corn transferred hot into a natural air drying bin.

Airflow (cfm/bu)	Hot Corn Moisture (%)
0.75	19 - 20
1.00	20 - 21
1.25	21 - 22
1.50	22 - 23

Choosing between in-bin cooling and high-low 2-stage drying can be based on the break-even costs between propane and electricity. Because in-bin cooling requires high-temperature drying to 16-17% first, more propane than electricity is used in drying. Conversely, more electricity is used during high-low 2-stage drying than in-bin cooling.

Table 2. Break-even costs of propane (cents/gallon) for drying corn with initial moisture contents of 24% to 28%.

cents/kWh	24%	26%	28%
4	22.5	21	20
6	32	30	27.5
8	45	40	36

Thus, if the propane charge is higher than the break-even table value, high-low 2-stage drying is cheaper. On the other hand, if propane is cheaper than the table values, high temperature drying followed by in-bin cooling is favored.

Table 3. Break-even costs of electricity (cents/kWh) for drying corn with initial moisture contents of 24% to 28%.

cents/gallon LP	24%	26%	28%
40	7	8	9
60	11	12	13
80	14.5	16	17.5

Thus, if the electric charge is higher than the break-even table value, high temperature drying followed by in-bin cooling is favored. On the other hand, if electric charges are cheaper than the table values, high-low 2-stage combination drying is favored.

Specialty Grains

Specialty grains such as food-grade white and yellow as well as high-amylose corn have to be handled much more delicately than regular commercial corn. Operating conventional drying equipment with the same temperature settings assures poor product quality. Field drying below 20% moisture and applying as little heat as possible are musts to minimize stress-cracking and/or denaturization of proteins. In addition, combination drying and multistage drying should be implemented as the preferred drying methods (see above).