



Task Force

Why Is Stored Corn Deteriorating Prematurely?

Dirk E. Maier, Agricultural Engineering

Quality deterioration of the 1992 stored corn crop is becoming a significant concern in parts of the Midwestern Corn Belt. Across the northern half of Indiana, numerous reports have been received about corn going out of condition prematurely in farm and elevator bins. Grain elevators are reporting increased damage discounts because of both visible heat and mold damage. The problems cannot entirely be attributed to poor management practices. Corn is going out of condition for many farmers and elevator managers who say they did a good job of drying and cooling the crop this fall. Additionally, the Indiana preharvest corn quality survey, conducted by Purdue University, showed below average problems with field fungi invasion and mycotoxin development.

Although the frequency appears to be highest for corn that was dried in in-bin drying systems (both low-temperature and high-temperature systems, including those equipped with stirrators), problems are also occurring in corn that was dried (and cooled) in batch and continuous-flow dryers, as well as in corn that was stored too wet.

Most commonly the following are observed:

- Crusting of the top corn layer due to sprouting and molding.
- Soggy wet surface corn due to condensation and moisture reabsorption.
- Hot spots due to temperature increases within a few inches or feet of the top of the pile.

Problems Caused by In-bin Dryers

It appears that the unusually high harvest moisture contents may have exposed corn dried

in in-bin drying systems to temperature and relative humidity conditions that decreased the allowable storage time significantly more than anticipated. For example, a typical bin dryer (24 ft. diameter, 7.5 ft. grain depth, stirrator, 10 HP fan) operated with a drying air temperature of 120° F requires about 41 hours to dry 26% moisture corn to 15% moisture, compared to 27 hours when drying 22% moisture corn. Thus, the corn would be exposed to the warm and moist drying conditions in the bin an additional 14 hours.

To make matters worse, if drying is stopped when the average moisture has reached 15%, the top 10 percent of the initially 26% moisture grain mass can still be above 17% moisture despite a complete stirring once a day; the top 10% of the initially 22% moisture grain mass, on the other hand, would be below 16% moisture. Furthermore, many bin dryers were operated this fall at too full a grain depth. If for the above example the grain depth is doubled to 15 ft., the drying time for 26% moisture corn to reach an average 15% moisture would more than double to 95 hours. The top 10% of the grain mass would still be above 17% moisture at the end of the drying period.

Unloading the grain into a storage bin and subsequent aeration cooling would not completely equalize the moisture throughout the pile. After a relatively short storage period, hot spots can develop anywhere in the grain mass. If the corn was not unloaded but was stored in the drying bin, crusting and subsequent spoilage of the surface layer can develop in a relatively short time given the rainy and relatively mild winter so far this year.

Compounding the problem, the stirring devices usually do not reach all the way to the bin wall. That leaves next to the wall a grain

layer of several inches, which for the most part remains undried and may even reabsorb moisture from wall condensation. Unless the drying bin is unloaded, this grain will tend to spoil quickly. If the bin is unloaded, the wet grain near the wall will be blended with the dry grain. However, if the blending is not thorough, hot spots may develop in storage bins from relatively small amounts of excessively wet grain.

Problems Caused by Column Dryers

For corn that was dried in column-type batch or continuous-flow dryers, an explanation for reduced storability is a bit more complicated. Past research has shown that if corn kernels reach temperatures above 140° F for extended periods during drying, slight chemical changes will occur that increase the equilibrium relative humidity of the air that will surround the kernel during the storage period.

The equilibrium relative humidity is the relative humidity of the air that will develop around a kernel of a certain moisture content if exposed to a specific air temperature for a sufficient period of time. For example, at a storage temperature of 40° F and a moisture content of 15%, the equilibrium relative humidity of the air surrounding a corn kernel is about 65%. However, if the kernel was dried at high air temperatures, the equilibrium relative humidity may reach 70-80% during storage at 40° F. Because the development of molds is not only a function of temperature but also of relative humidity, an increase in relative humidity will lead invariably to a higher potential for mold development and subsequent spoilage even at low storage temperatures.

Furthermore, drying at fast rates and at high temperatures increases the stress-cracking of corn kernels. For example, if 26% moisture corn is dried in a typical continuous-flow dryer at an air temperature of 180° F, the normal drying time is about 2.1 hours; the kernels reach an average temperature of about 170° F. On the other hand,

if the air temperature is increased to 220° F, the drying time decreases to 1.3 hours, but the average kernel temperature increases to about 200° F. This difference increases the breakage susceptibility of the corn as it is subsequently handled. Broken kernels and fine material are a source of mold spores and are also more vulnerable to mold growth than whole kernels. They also restrict airflow, which causes uneven aeration cooling in the stored grain mass.

Problems Caused by Holding Wet Corn without Drying

Because the drying operation created delays on many farms and elevators, some of the harvested 18-20% moisture corn was stored "temporarily." Under cold-air aeration, the corn quality can be maintained below 40° F for 3-4 weeks. However, this approach reduces the allowable storage time (AST) and spoilage may reduce the corn's market grade. For example, corn harvested November 1 at 20% moisture has an AST of about 63 days when held at 50° F. If by December 1 the storage temperature is reduced to 40° F, the AST is extended by an additional 74 days. If the grain is not dried within that time period, mold development and spoilage probably can not be avoided. Those who are still holding wet corn need to dry or move it immediately.

Solutions to Counteract Deteriorating Grain

The above problems were compounded this year by a late (and frequently interrupted) harvest, the generation of excess trash and fine materials during combining, overloading of storage bins due to the high yields, and a mild and humid winter that has hindered the thorough cooling of the binned grain. Farmers and elevator managers now can initiate only a limited number of measures to counteract these problems.

The primary one is to check the bins twice a week, if not daily. Because the grain moisture contents can increase during storage, especially near the exposed top surface, grain samples from the surface and 6 to 12 inches into the grain should be taken at several locations. If the moisture content is higher than 14.5-15%, or if crusting or rewetting occurred, producers should remove the affected grain immediately by drawing a core.

If no temperature cables are installed in the bin, grain temperatures should be measured by probing 3-6 ft. into the grain at several locations. If temperatures begin to rise noticeably, a hot spot may be developing. The aeration fans should be turned on immediately. On bins with corn of questionable keeping quality, it may also be advisable to operate the aeration fans for a few hours every week during cold weather periods. If the corn has been cooled out thoroughly and is in good condition, the fan should be sealed to reduce updraft into the bin. When removing grain for sale or for feed, it is advisable to draw it from all storage bins. Rotating between bins will keep the bins cored, and the surface layers exposed for minimal time periods.

With the relatively low corn prices, farmers will continue to be reluctant to move cash grain. However, they must consider the potential storage risks. Discounts due to spoilage damage may be significant enough to offset any potential price gains. Also, winter frost laws will go into effect in many counties by late February, reducing the ability of farmers to move large amounts of borderline grain to elevators during that time.

There is one more important matter. Currently about 100 million bushels of corn are under ASCS loans in Indiana. Maintaining the quality of this corn is the **farmer's** responsibility, not ASCS's. If producers are concerned about moving grain in and out of ASCS loan bins, they should talk with their local officials about their grain quality concerns. Generally, ASCS will be flexible as long as the right quantity remains on

the farm! It is very important to be able to draw a core out of an ASCS loan bin; the corn removed can always be recirculated back on top of the pile.

Important Safety Precautions

With more frequent checking of bins comes the increased risk of accidents, so the following precautions assume added importance.

- Review safety measures with employees and family members.
- Watch for falls off ladders, and never enter a bin while grain is being unloaded. It only takes 3 or 4 seconds to become helpless in flowing grain.
- Before entering the bin, lock out the unloading augers.
- Once grain has been removed, bins should be entered only by a person who is secured with a rope and safety harness to two people outside the bin.
- Bridged grain and cavities may collapse and trap a person quickly. Beware of plugged unloading spouts and steep grain piles; dislodge either of them carefully with a long pole.
- Because mold spores are airborne, they can be inhaled, causing irritation and severe illness. A dust mask capable of filtering fine particles should be worn while inside the bin.

Summary

Unfortunately, the long-term storage potential of significant amounts of the current corn crop into late spring or even summer does not look promising for much of northern Indiana and the northern Corn Belt. It is critical for farmers and elevator managers to honestly assess the quality of their binned crop, and to evaluate options for selling or feeding versus extended storage.

