Managing Stored Grain during Fluctuating Temperatures in the late Fall and Winter

Managing grain quality during late fall and winter is an ongoing chore that can be even more challenging when temperatures fluctuate on a daily basis. To avoid grain quality loss, growers should be aware of what changing temperatures can possibly do to stored grain and what important steps that can be taken to manage grain temperatures.

Why changes in temperature can cause storage problems for grain.

Inconsistent air temperatures can occur frequently across much of the grain producing areas of the United States and Canada in late fall and throughout the winter. Checking the condition of stored grain during this period is crucial to maintaining the quality and value of the product. Crusted, wet, or sticky kernels can be signs of trouble inside the grain bin.

Solar radiation in the winter can cause issues when it comes to grain temperature. The amount of solar energy on the south side of a bin in February is much greater than in June. Grain within two feet of the bin walls may be warmer than the average air temperature (Figure 2).[1]

Figure 1. Grain bin in winter.

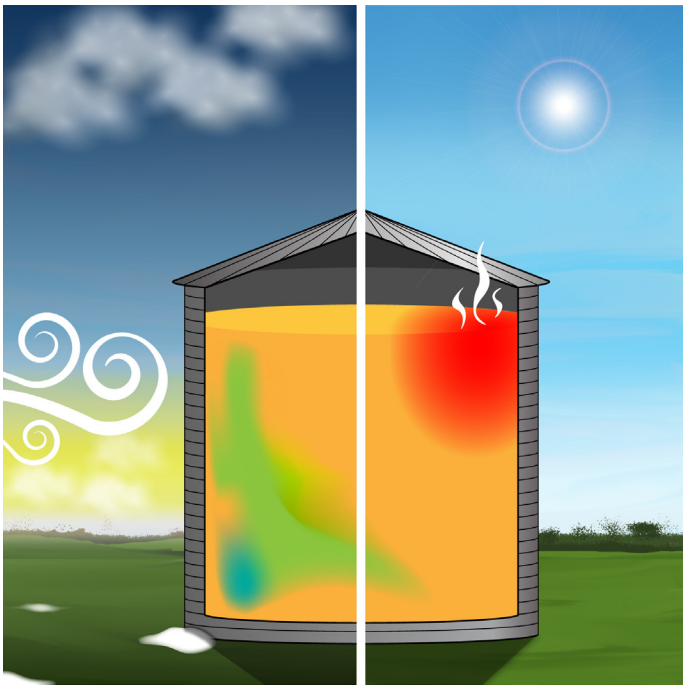

Figure 2. Illustrating the effects of potential temperature swings throughout a given day during the fall and winter months.

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The most important cause of deterioration of dry stored grain is grain temperature. If temperature is not controlled, moisture can migrate from one part of the grain mass to another, where it can accumulate and potentially cause spoilage.[2]

What causes air and moisture to migrate within a grain bin? It is estimated that the air space within a grain mass can range from about 30% to 60% of the total space. The temperature of the air surrounding the grain is about the same temperature as the grain. As average daily temperatures outside of the bin decline in late fall/early winter to 20 °F and colder, the walls of the bin also become cooler. Since grain has fairly good insulation properties, most of the center mass of grain (and the air surrounding the grain) remain at about the same temperature as when the grain was placed in storage. These temperature differences create a circulation of air and moisture known as convection currents. The cooler air surrounding the grain near the bin walls becomes denser and settles near the bin floor. It then migrates toward the center of the grain mass where the warmer grain increases the air temperature, causing it to become less dense and rise through the warm grain. As it rises, the air absorbs small amounts of moisture. Then the air continues to make its way into the upper part of the grain mass and the top of the bin, which is cooler. As it cools, condensation can occur, and moisture is deposited in the grain. This can lead to spoilage (moldy grain) and/or crusting, usually in the top center of the grain surface.[2]

What is Equilibrium Moisture Content and why is it important?

Equilibrium moisture content (EMC) is the percent moisture content at which grain will stabilize, given a certain temperature and relative humidity (RH) of the air surrounding the kernels. The EMC charts for several types of grain crops can be found at this link: https://extension.okstate.edu/fact-sheets/aeration-management-knowing-when-to-run-aeration-fans.html.

Why is this information so important to grain storage managers? Regardless of how much air fans supply to a bin, the temperature and RH of that air will dictate whether the grain will decrease or increase in moisture content (MC). The stabilization time is impacted by the amount of air supplied. However, the final grain moisture content is determined by the temperature and relative humidity of the air. If a certain MC is desired for the grain being stored, it is important to know whether air being supplied will either deposit moisture in the grain or remove moisture from the grain. If the desired condition of the grain cannot be met given the temperature and RH of the air, then it is not cost efficient to run the fans. For example (Table 1), if corn is being stored in a bin and the outside air conditions are 50 °F and the RH is 70%, the resulting MC of the grain aerated over time will be an EMC of 15.7% (using the EMC chart for corn found in the link above). If the goal is to maintain or reduce the moisture content, do not run fans in conditions that would cause a higher MC as found in the EMC chart.[4] Once a stored crop is close to a safe storage moisture, aeration can be more efficient. If corn inside the bin is at 16% moisture, and you want to dry it to 15%, running the fan in air condition scenarios A, C, E and F (Table 1) would help achieve that goal, as the EMC's are lower than 15%. Scenarios B and D would not achieve that goal as the EMC's are above 15%.[5]

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Table 1. Equilibrium Moisture Content for corn resulting from three different temperature and two different relative humidity levels.

Air condition scenario	Air Temperature (°F)	Relative Humidity (RH)	Equilibrium Moisture Content
A	40	50	12.7
B	40	70	16.4
C	50	50	12.2
D	50	70	15.7
E	70	50	11.2
F	70	70	14.5

Adapted from Aeration management: Knowing when to run aeration fans. Oklahoma State University.[4]

Tips on managing stored grain during temperature fluctuations.

- Monitor grain temperatures at least every two weeks.[3]
- Be aware of the major daily temperature fluctuations in your area. It is typical during the fall and winter to have cooler, moist mornings with temperatures of about 30 °F that rise into the 50's, 60's and even the 70's °F during the afternoon hours. Some regions of the country can experience this on a regular basis.
- Automated systems can also help manage grain if you just need to cool it. Some growers may have their grain come in at optimal moisture but need to cool it in order to increase storage life. Warm and dry air may not be the optimal fix, but an automated system can help run cool air through the grain at certain times of the day to cool it down to the desired temperature and maintain moisture content.

Safety

The dangers of grain handling cannot be stressed heavily enough. NEVER enter a bin when the grain is flowing and be extremely cautious around all grain handling structures and equipment. EXTREME CAUTION should be used if entering a bin with moldy grain or if the upper layer of grain is crusted. Be sure to have safety precautions and emergency plans in place and make them known to all workers and bystanders on the farm.

Sources:

[1]Mahrenholz, A. 2022. Keeping your grain safe in fluctuating temperatures. Purdue University Extension. https://extension.purdue.edu/news/county/pike/2022/03/pike-keeping-your-grain-safe-news.html

[2]McKenzie, B. and Van Fossen, L. 1995. Managing dry grain in storage. Purdue University Extension. AED-20. https://www.extension.purdue.edu/extmedia/AED/AED-20.html

[3]Hellevang, K. 2020. Proper spring grain drying and storage critical. North Dakota State University. Extension and Ag Research News. https://www.ag.ndsu.edu/news/newsreleases/2020/march-23-2020/proper-spring-grain-drying-and-storage-critical

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[5]Dawson, A. 2013. Knowing when it's time to turn on the aeration fan. Manitoba Co-operator. https://www.manitobacooperator.ca/crops/knowing-when-its-time-to-turn-on-the-aeration-fan/

Additional sources:

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