PRE-FIRE GRAIN ISSUES

INTRODUCTION

Imagine a grain bin full of grain. How many bushels does that bin hold? What is the current or future price of that grain? Now pretend that that same grain bin is full of dollar bills or maybe five-dollar bills. Would an owner/operator who was trying to protect that money watch it each and every day? Would the owner/operator take corrective action if the dollar bills started to heat up or start to spoil? Keep in mind that no one wants to pay you for burnt or moldy dollar bills and if you don't do something, then you lose everything in the bin.

The first step in understanding and maintaining grain conditioning starts with incoming grain. The farmer or operator must know what condition the grain is in before putting the grain into a grain structure. Through grain grading, we better understand moisture content, foreign material, temperature, grain quality, etc. – also known as Grade Factors. However, if we are not continuously checking grade factors – then how do we know what we are storing and how we need to maintain it?

Once commodity grain is placed into storage after harvest, it has no other purpose than to start to spoil. Grain quality in storage never gets better – it only stays the same for a short time or it worsens. Grain operators must realize that it is their tasking to keep grain in as good condition as possible while in storage. This means that if an operator expects the grain to maintain the same grade factors as they received it, they must work each day to protect it. Those who do not evaluate grain condition daily can run the risk of grain quality going down which translates to poorer marketing opportunities and diminishing return on investment or loss of money.

GRAIN TYPES – BEST OR WORSE TO STORE

While there are many different types of grain or Raw Agricultural Commodities (RAC), some are easier to store than others. This is due to the berry size or size of the commodity. The smaller the berry or commodity grain, the more compact the grain is while in storage, and harder for air to circulate around the kernel and thus harder to cool. Larger grain kernels offer a chance for air to circulate around the kernel and keep grain cooler while in storage. Maintaining the grain in a cool state reduces the chances for heating which is the indicator for grain going out of condition.

Corn, soybeans, wheat, milo, rice, oats, canola, flax, barley, rye, and lentils are just a few grain types that are harvested and placed into storage awaiting further processing. Each grain or commodity has its own good and bad aspects of maintaining quality. Operators need to be very aware/knowledgeable of the commodity they are storing and where they are storing it to get the best results.

Foreign material (FM) and grain moisture are two constants that must be considered when placing grain into storage and will vary by grain type and area of the country.

GRAIN MANAGEMENT PLAN

As harvest nears, it is important that every step along the supply chain has a Grain Management Plan in place to work towards while grain is in storage. For the purpose of this paper, the supply chain would consist of the farm, commodity grain elevator, and processor or mill.

Typically, a Grain Management Plan would be built around the following questions for your farm or facility:

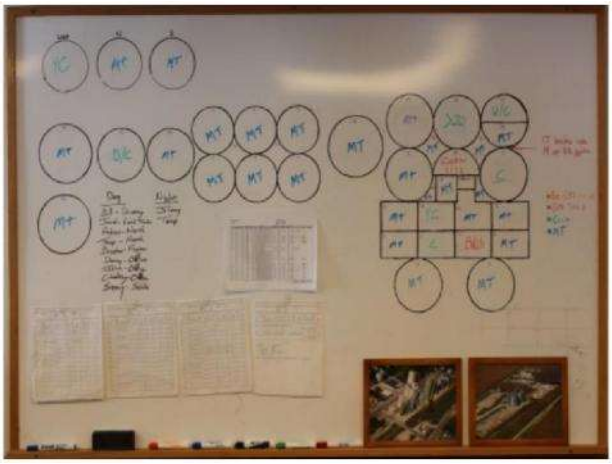
1. Is there room in storage for new grain vs last year's crop?
2. What is the condition of the grain storage structure? Are there water infiltration issues at the roof, sidewalls, base or at gates, man-doors, aeration ducks or other penetrations?
3. How long do you expect to keep the grain in storage?
4. Is there a place we can go with grain if there is a problem?
5. What is the moisture content and condition of the incoming grain?
6. Do you have a way to dry down crop as it is going into long term storage?
7. Is there a plan of what to do if the crop yield exceeds expectations?
8. Does everything work within the storage to maintain crop conditions for length of time?

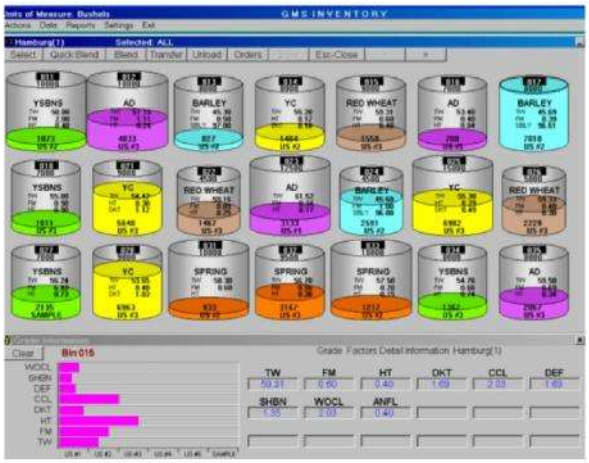
Every farm or commercial grain operations should go into harvest with a Grain Management Plan. Farm operations and commercial grain operations should work with grain marketing to finalize these plans prior to harvest. Having a plan in place can give operations a chance in knowing how to manage their grain in storage until sold. Even if plans change during the marketing year and grain does not go to a market when planned, operators can adjust as long as there is communication and expectations set.

WHAT DOES GRAIN CONDITIONING MEAN?

Grain conditioning problems originate from only a few areas. Special focus on these areas will assist in keeping grain in condition for a longer period.

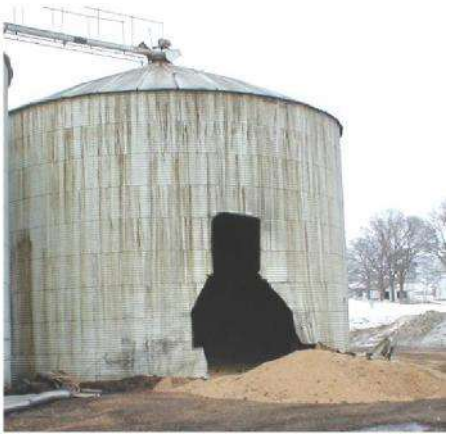
1. Moisture content of grain while in storage.
2. Temperature of grain while in storage.
3. Insect and mold activity while in storage.
4. Areas of crusted or clumped grain at the top surface or on sidewalls.
5. Poor grain deteriorating into worse grain.





It should be noted that before grain is placed into storage (long term or short term), operators should know the moisture content of the grain, foreign material, insect activity, mold or toxin levels, temperature and grade factors of grain. If grain going into storage exceeds thresholds of good grain storage management, grain will immediately start to spoil, and operators will have a difficult time managing the grain.

Keeping grain in condition means that the operator is paying close attention to the grain while in storage. The operator is looking at grain temperatures or spikes in temperatures which indicate a problem. The operator is also using their senses of smell and sight to determine if grain is producing a sour smell or droplets of condensation on bin lids or doors. These are indicators of grain heating up as it is going out of condition and operations must react to counter these conditions.



Lastly, grain condition has a lot to do with the structure the grain is placed in. Off grade grain (grain already going out of condition) should not be placed into structures that are difficult to check or maintain grain quality. Also, some consideration should be placed on how easy it is to unload or remove grain from the structure. Grain that is harder to remove/unload or check, should be the best quality grain. Conversely, grain that is easier to remove/unload and check, is of poorer quality. This thought process should go back to the plans made in the Grain Management Plan and every effort should be made to stick to that plan.

GRAIN TEMPERATURE/CONDITION SYSTEMS OR CHECKS

Grain Temperature Cables – Each bin has cables attached to bin top and bin bottom. It will depend on the size of the bin as to how many cables are installed. Cables have thermo-couples which sense temperature. Cables report back to a computer system or a "Read Box". Grain operator then reads system to determine if the thermocouple is detecting a "hot spot" in the grain or rise in temperature. Typically, the operator can tell which cable and thermo-couple on cable is sensing the temperature rise. This is a good, proven system for grain temperature monitoring. However, it is common for thermo-couples or even other systems to stop working; these require constant maintenance while the bin or structure is empty. Can be found in most upright concrete, upright steel (if so designed to carry the load), some flat stores, and one cable in a ground pile or bunker. Temperature cable checks should be performed daily by grain operations and results recorded for each thermo-couple for trending. If temperatures rise, the operator can pursue corrective action. Keep in mind that a "hot spot" would need to creep its way to a thermo-couple to show a problem. Depending on how many cables are installed in the structure and how many thermo-couples are working, might make a smaller problem become big just because of the amount of grain effected by the "hot spot".

CO2 Monitoring – CO2 (Carbon Dioxide) monitoring is becoming more prevalent in the grain handling industry. Spoilage of grain emits carbon dioxide. Monitors can detect the slightest elevation in CO2 and sound an alarm on phones, computers, etc. Operators would be notified that there is a problem within the structure. There are two types of CO2 monitors. The first is a simple monitor which is placed at the bin top and has a way to communicate with devices. While this is better than nothing, it will only be able to tell you that within the space, there is a rise in CO2 – but will not pinpoint where the problem is. If this monitor is used in a large upright steel or large flat store, there may need to be large amounts of grain removed to find the problem. The second is a better approach. CO2 monitors are now installed with temperature cables. The monitors are more frequent in the bin and can provide more information on where the problem is occurring. This solves the problem of having to wait until the "hot spot" creeps over to a thermo-couple as it will pick up the rise in CO2 long before it reaches the cable.

Probing and Obtaining Samples – Probing and sampling of grain is a way to monitor grain and, in some cases, might be the only way to monitor. Probing and sampling is typically used on those bins or structures which do not have temperature cables installed or cables are not working. It requires the operator to remove a relative sample of grain to run testing looking for heated grain, smell, deterioration of grain, foreign material, etc. In some cases, bin bottoms can be opened to retrieve a sample. In other cases (like large flat structures or ground piles and bunkers) samples cannot be easily retrieved through bottom augers or conveyors. In this case, hand probes are used to collect the sample. Power probes can be used to get deeper into stored grain. While it may not be the very best at

achieving a representative sample of the entire structure, it is data and can indicate a problem. Results would be recorded, and trending would be expected from last samples taken.

> ***Note of Caution: Entering a grain structure with grain is dangerous. Entering a grain structure to obtain grain samples must be done safely or not at all.***

Using the Five Senses – In some cases, grain operations do not have any mechanical or sampling method to check condition of grain. While this section should not be the end all – be all approach to monitoring grain, it is a good augmentation of different methods to monitor the grain. As grain heats, it produces a smell which is a "sour" smell unlike good grain. That smell is an indicator that grain is going out of condition. Smell is typically used by smelling into a grain bin or structure but can also be used by during on aeration fans and blowing air out. If the operator notices a "sour" smell, there is more than likely a problem developing within the structure. Another sense an operator can use is sight. By opening bin lids or doors, an operator might notice condensation developing on these surfaces. Again, this is a strong indication that grain is heating, and action must be taken.

Grain Spreaders: Technological advancements in the construction of grain bins has made it possible to reduce the exposure for out-of-condition grain by filling it in a nontraditional manner. A grain spreader is a device that has eight to sixteen chutes that distribute the grain once the grain flow enters the bin roof. These spreaders will evenly distribute the grain while filling the bin, eliminating the buildup of fines in the core caused by traditional loading methods. These spreaders are shown to reduce crusting of the grain and are adjustable on the outside of the bin.

CONDITIONING ISSUES WITH DIFFEENT TYPES OF STORAGE

Upright Concrete – Upright concrete is typically classified as a good vessel in which to keep grain in condition. Typically, if managed correctly, it is easy to move grain around to cool or condition grain due to space and equipment. With the number of bins to work with, it should be easier to blend, aerate, receive and ship grain. However, upright concrete has its own set of issues like sweating concrete and just the sheer number of bushels to deal with which can lead to grain conditioning problems. There are other concerns like bug infestation and the mere fact that it is extremely difficult to enter and clean bin bottoms. For both Concrete and Steel: clumps of out of condition grain can plug reclaim gates making them difficult to unload properly, requiring alternate means to empty the vessel without causing damage to it.

Upright Steel – Upright steel is classified as a good vessel in which to keep grain in condition. Most large upright steel bins are manufactured and installed with good aeration floors, grain temperature cables, and large fans. However, if grain starts to go out of condition, it is sometimes difficult to catch there is a problem, identify exactly where is the problem is, and move enough grain out to cool the grain. If the structure is not manufactured for use of temperature cables, then operators need to find another way to check on grain conditioning like samples or smell through aeration fans. While this is something, it may not catch a problem immediately. Only dry (low moisture) grain should be placed into upright steel for long term storage.

Flat Storage Structures – Flat storage structures are used throughout the grain industry for many different types of grain. In most cases, large flat stores have temperature cables installed, can store

many bushels of grain and can be good storage. However, once grain is placed inside a flat store, it is harder to manage (operationally) than upright concrete or upright steel. Finding hot spots in grain and then reacting to the hot spot is difficult as many flat stores are filled through a top conveyor or auger but must be emptied utilizing powered equipment instead of conveyors or augers. If not equipped with temperature cables, operators need to find a way to understand grain conditioning though samples or smell through aeration fans. Only dry (low moisture) grain should be placed into a flat storage structure.

Grain Piles or Bunkers – As grain yields continue to rise across the nation, the use of ground piles or bunkers is seen to store a lot of bushels without the costs of building an upright concrete, upright steel, or flat storage structure. Ground piles or bunkers should be considered short term storage and not long-term storage due to being out in the elements even if there is a tarping system applied. Tarps must be used to protect the grain. Grain typically is conveyed or augured into the pile and the tarp is installed. Advanced grain monitoring systems can be purchased that includes a temperature cable system, wireless fan controls, wireless CO2/Humidity sensors, and monitors that will automictically activate a backup generator should the facility experience a power failure. These wireless systems are controlled remotely through smartphone capabilities. Grain is removed from the pile by powered equipment and a steady flow of trucks. Only dry (low moisture) grain should be placed into a ground pile or bunker.

Grain Bags or Bag Silos – Many farmers and some commercial grain operations companies are utilizing grain bags or bag silos to store grain for a short term. Bags can measure up to 12 feet in diameter and 328 feet in length. Bags are typically used for corn, wheat, and soybeans. While use of the bags is considered better than storing directly on the ground or uncovered, there are grain conditioning issues with the use of these bags. Grain under 15% moisture or lower should be used to fill bags. Constant monitoring for moisture and temperature should be accomplished while in storage. Inspection of bags for animal rips and tears should be performed. Site should be prepped before filling and special equipment is needed for loading and unloading bags.

Aeration – Aeration systems are important to protect the quality of the grain while in storage. Each facility should develop an Aeration Plan for each storage structure on site. As part of an overall Stored Grain Quality Management Plan, each facility should develop an Aeration Plan for each storage structure. Aeration is one of four best stored grain management practices which include sanitation (cleaning) of storage structures before harvest, properly loading a bin and coring a grain mass, and consistent temperature and CO2 monitoring of grain during storage.

When grain is stored at the recommended safe moisture content such as 15% for corn in the Midwest, it is best to cool grain down from harvest temperature (or grain temperature coming out of a grain dryer) to below 50 degrees early in the fall. In the Midwest, corn and soybean farmers and grain elevator operators would also want to bring their grain temperatures down to below 40 degrees in late fall and around 30 degrees or less for winter storage. Then, as winter turns to spring, operators would want to

keep cold grain cool by sealing aeration fan openings especially if the grain is: 1) at the safe moisture content for longer-term storage, 2) the grain mass has been cored, and 3) monitoring indicates temperatures and CO2 readings are stable.

Newer bin technology provides the option to ventilate headspaces independently off the grain mass, best practice now is to hold the grain at cold temperatures as long as you can. Headspace ventilation removes condensation without warming the entire bin. Aerate grain with as low dewpoint air as possible when the grain does need to be warmed up.

CONCLUSION

Keeping grain in condition while in storage is not an easy task. Grain in storage immediately starts to spoil and requires operations personnel to monitor grain temps and condition constantly. Catching a problem early and taking action will prevent your grain from deterioration and possible fire.

Call or email the NWAG hotline with questions at GrainTaskForce1@nationwide.com .