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Wet Fall Weather, Flooding, Kernel Sprouting and Molds

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While corn grain yield is determined over the full season, grain quality is often established by conditions at the very end of the growing season. During wet fall weather growers need to move quickly on deteriorating grain.

Flooded corn

Grain submerged by uncontrolled flood waters is considered Adulterated under the Food Drug and Cosmetic Act. This policy dates to 2008, and has been applied to several situations since then. Adulterated material cannot be put in commercial facilities of any type, where there would be a chance of entering human or animal food.

A possible disposition strategy that does not involve a commercial facility:

1. Make a 3rd party documentation of the affected area (GPS, photo documentation of water depth). This would probably be done by a crop insurance adjuster, and would have to be done before harvest to preserve insurance coverage.
2. Harvest the grain as soon as possible to limit further spoilage. Dry immediately to below 14% moisture, and keep wet holding time to a minimum. Isolate both wet and dry grain from each other.
3. This grain should not be taken to a commercial elevator, warehouse, or feed mill.
4. Clean combines, wagons, and handling equipment as completely as possible.
5. Feed in a documented on-farm livestock feeding plan approved by a veterinarian. Test for potential hazards--mycotoxins, heavy metals, PCB's, pathogens--appropriate for the species to be fed based on knowledge of the flooding situation. Test result documentation and feeding records should be retained.
6. If testing is done, submit at least 10 lbs (shelled) collected from multiple locations across the area of grain that was submerged. Veterinarians have access to various university Vet Diagnostic Labs, but there are also commercial laboratories that can test for these factors. Refrigerate the samples and submit as quickly as possible.
7. This grain should never be fed to dairy animals or laying hens.
8. If an on-farm feeding plan meeting these conditions is not possible, the grain should be destroyed in the field or after harvest, using methods accepted by FDA and local health officials.
9. Hay and silage is normally fed on-farm; the same criteria for testing and feeding corn applies to hay and silage. Flooded hay should not be baled and taken to a hay auction.

Regulatory policy and officials are not involved in the price/value determination. Grain that was above the water line is marketable, although mycotoxin testing may be advisable.

Kernel Sprouting

Corn kernels possess several mechanisms that prevent sprouting before maturity. The primary mechanism is a balance between two growth hormones, gibberellic acid (GA) and abscisic acid (ABA). In general, GA promotes germination and ABA inhibits germination. The concentrations of ABA in corn kernels peak during the middle of seed filling and begin to decrease as the seeds near maturity. Before maturity, seeds are prevented from germinating even though water content and other factors would stimulate germination. After maturing, seeds of most of grain crops are capable of germinating if conditions are favorable. Unfortunately, this also means that, seeds from normal corn plants can germinate on the ear if certain weather events occur.

The two primary requirements for seed germination are temperature and moisture. The minimum temperature for corn seed germination is about 50°F. Germination can occur within a couple of days with temperatures in the 80s. Critical grain moistures that stimulate germination are above 30%. In normal years, grain dries as it matures to moisture percentages far below requirements for germination.

Normally, corn husks protect mature kernels from moisture that may cause germination. If the ear turns downward at maturity, the husks shed water and the chances of kernels sprouting on the ear are almost eliminated. But, if the ear remains upward, water from rain or even a heavy dew may run down the inside of the husks and pool at the butt end of the ear. Husks trap water near the kernels and if temperatures are above 50°F kernels will likely germinate. Sprouting on the ear is almost always limited to several rows of kernels at the butt end of the ear because this is where water is trapped.

There are several factors that determine whether a corn ear remains erect or "droops" (points downward) following physiological maturity. Ears of corn normally remain erect until sometime after physiological maturity has occurred (black layer development), after which the ear shanks eventually collapse and the ears droop. However, ears may droop in drought-stressed fields that have not yet reached physiological maturity. A loss of turgidity in the ear shank due to water stress, possibly combined with some cannibalization of carbohydrates in the ear shank may eventually cause the ear shank to collapse, resulting in ear drooping. In certain hybrids, ears remain upright following physiological maturity (or remain erect for a longer duration) which can be related to a shorter ear shank. According to some seed company agronomists, prior to the development of Bt hybrids, corn breeders tried to reduce ear drop due to European corn borer damage by shortening ear shanks. Some of that germplasm has continued to be used in more recent hybrids. Breeders acknowledge the concerns that upright ears are slower to dry or more prone to ear molds and indicate that companies are looking for more droopy shanks to help protect ears from water damage. However, they contend that there are other genetic components to these traits and that the effects of upright ears on fungal infections may not be as pronounced as is widely thought.

In addition to genetic differences among hybrids, environmental conditions and cultural practices may affect ear orientation during the drydown period prior to harvest. In ongoing field research that compares multiple hybrids varying in maturity, differential responses to plant population for % ear erectness (at maturity) are observed. The percentage of erect ears usually decreases significantly as plant population increases. These results suggest that factors other than hybrid genetics can determine if an ear is in an erect or droopy position at harvest.

Premature sprouting is quite damaging to grain quality and reduces safe storage time. During germination, seeds release enzymes that break down carbohydrates, proteins and fats. This breakdown releases free sugars, amino acids, and fatty acids. These simple compounds spoil easily in storage and stimulate fungal growth. The corn kernel pericarp ruptures during germination, and this makes the grain vulnerable to invasion by fungi and insects. Germinated seeds will crack during combining. Debris from sprouted seeds will often accumulate in the center of a bin and may be a fire hazard.

Unfortunately, sprouted kernels is a permanent damage to grain. Spread of the damage can be reduced by timely harvest and quick drying of grain to stop germination and grain deterioration. If possible, grain should be screened to remove debris before storage. Be aware that dockage at the point of sale may reduce grain price.

Field Mold

Molds can cause serious problems if fed to livestock and can be food safety problems in the supply chain. Buyers look for moldy corn and other quality problems. For those with crop insurance, quality losses due to moldy corn can trigger indemnities if losses are large enough. **Farmers suspecting losses due to moldy grain should contact their crop insurance agents before they harvest.** The company will follow-up and tell you how to proceed.

Corn is susceptible to field mold, which can emerge rapidly. Some yield is often lost, but more importantly, field dry-down and storage properties are be reduced. Test weight of 54-55 lb/bu may be high this year. If wet and humid weather persists, regardless of temperature, expect wetter than normal corn at harvest. Fungi will invade stalks, which makes stalks weak in many cases. Stalk rots can progress into the cobs, and eventually into the kernels. Scouting and early harvest will be needed to prevent field loss from both downed stalks and mold activity. If weather turns to very low humidities at the end of September through November, the mold threat will be removed.

Fusarium/Giberrella are typically the most common fungi on corn ears in Wisconsin. This group of fungi not only damage kernels on ears, but can also produce toxins called mycotoxins. These toxins (fumonisins and vomitoxin) can threaten livestock that are fed contaminated grain. Thus grain buyers actively test for mycotoxins in corn grain to monitor mycotoxin levels to be sure they are not above certain action levels established by the U.S. Food and Drug Administration (FDA).

The FDA has established maximum allowable levels of fumonisins in corn and corn products for human consumption ranging from 2-4 parts per million (ppm). For animal feed, maximum allowable fumonisin

levels range from 5 ppm for horses to 100 ppm for poultry. Vomitoxin limits are 5 ppm for cattle and chickens and 1 ppm for human consumption.

Reducing Mycotoxin Risks: Before harvest, farmers should check their fields to see if moldy corn is present. Similarly, during harvest they should carefully monitor the grain for mold. If substantial portions of fields appear to be contaminated with mold, it does not mean that mycotoxins are present and vice versa. Appropriate grain samples should be collected and tested by a reputable lab. Work with your corn agronomist or local UW Extension agent to ensure proper samples are collected and to identify a reputable lab. If tests show high levels of mycotoxins in grain, that grain SHOULD NOT BE BLENDED with non-contaminated corn.

If you observe mold in certain areas of the field during harvest, consider harvesting and storing that corn separately, as it can contaminate loads and the fungi causing the moldy appearance can grow on good corn during storage. Harvest corn in a timely manner, as letting corn stand late into fall promotes Fusarium ear rot. Avoid kernel damage during harvest, as cracks in kernels can promote fungal growth. Also, dry corn properly as grain moisture plays a large roll in whether corn ear rot fungi continue to grow and produce mycotoxins. For short term storage over the winter, drying grain to 15% moisture and keeping grain cool (less than 55F) will slow fungal growth. For longer term storage and storage in warmer months, grain should be dried to 13% moisture or less. Also, keep storage facilities clean. Finally, mycotoxins are extremely stable compounds: freezing, drying, heating, etc. do not degrade mycotoxins that have already accumulated in grain.

Diplodia ear rot does not produce mycotoxins, but can damage grain. This disease is often more severe in years where dry weather precedes silking, followed by wet weather immediately after silking. While this disease does not result in mycotoxin accumulation, it can cause grain yield loss and quality issues. Diplodia ear mold can cause lightweight kernels with a dull grey to brownish color and sometimes small black structures call pycnidia. The infected kernels are prone to breakage and can result in poor test weights, poor grain quality and fine materials in the hopper or grain bin. Adjusting combine settings can help to maximize grain cleaning and minimize breakage. Factors such as planting date, the timing of rain events after fertilization and hybrid susceptibility can result in a range of damage within the larger region and even within a farming operation. The price at which a farmer can market grain begins to decrease for every percentage point of damaged kernels above 5% and some grain elevators will set a damage threshold above which they will not accept the grain (15 to 50% damage) depending upon the end use and how quickly the grain will leave the elevator. It is important for those producers that encounter Diplodia ear mold to be in communication with their crop insurance agent.

Stenocarpella maydis, the fungus that causes Diplodia ear mold, metabolizes the starches in corn kernels leaving them lighter weight than non-infected kernels. The ethanol manufacturing process uses bacteria to turn corn starch into simple sugars, eventually fermenting them to yield ethanol. Diplodia-damaged kernels can yield less ethanol and may be why elevators that supply ethanol plants may have a lower threshold for damaged kernels than others.

One positive is that unlike Aspergillus and Fusarium/Gibberella ear molds, Diplodia ear mold is not associated with a mycotoxin. However, regardless of whether infected kernels are in the field, in the combine hopper, semi trailed or grain bin, unless the grain is cooled and dried to below 15% moisture, the fungus will continue to grow and metabolize starches, lowering test weights and grain quality. Additionally, unless properly dried, the fungus can colonize uninfected kernels that are damaged during harvest or storage operations.

Crop Insurance Rules: Quality losses due to moldy corn are insurable losses for those with crop insurance, but to claim indemnities, growers must follow crop insurance rules. If you suspect mold issues, contact your crop insurance agent before harvesting, storing or selling the corn. The key is to communicate with your crop insurance agent before harvesting. Your crop insurance agent will tell you how to proceed. Samples will have to be collected by a third party, such as a crop adjustor, plus many grain elevators will collect and store grain samples short-term for crop insurance purposes for loads with discounted prices due to low quality. Also, growers may be asked to leave unharvested rows for crop loss adjustors to use to determine indemnities. If fumonisin or vomitoxin tests indicate contamination above safety limits, insured growers following proper procedures will be compensated for the reduction in value of the grain if it is large enough to trigger insurance indemnities.

For more information about ear rots and to download a helpful fact sheet produced by a consortium of U.S. corn pathologists, visit this webpage: http://cropprotectionnetwork.org/corn-diseases/ear-rots/. For more information on mycotoxins and to download a fact sheet, visit this webpage: http://cropprotectionnetwork.org/corn-diseases/mycotoxin-faqs/.

Storage

Fungus development: Continued wet weather and warm humid conditions can retard drydown and encourage fungus development on ears. Some fungi produce mycotoxins harmful to animal and human health. Some fungi, such as diplodia ear rot, do not produce mycotoxins while others such as fusarium or aspergillus can be toxigenic. Expect feed mills and ethanol plants to screen early harvest samples for toxins. Field scouting can help identify problems before harvest.

Moldy grain: Moldy grain will have shorter storage life than 'clean' grain held at the same moisture and temperature. The data in Table 1 represents the long term averages. For grain carrying field mold, expect perhaps 60% to 70% of normal shelf life.

Table 1. Maximum storage time (months) of corn*

Temperature (°F)	Corn Moisture content						
	13%	14%	15%	16%	17%	18%	24%
40	150	61	29.0	15.0	9.4	6.1	1.3
50	84	34	16.0	8.9	5.3	3.4	0.5
60	47	19	9.2	5.0	3.0	1.9	0.3
70	26	11	5.2	2.8	1.7	1.1	0.2
80	15	6	2.9	1.6	0.9	0.9	0.06

* Based on 0.5% maximum dry matter index - calculated on the basis of USDA research at Iowa State Unviversity. Corresponds to one grade number loss, 2-3% points of Total Damaged grain.

Storage life: The storage life of grain starts immediately after harvest and is shortened significantly when stored at warm temperatures. One day of holding warm, wet corn before drying can use as much as 50% of the storage life, therefore increasing the likelihood of storage problems next spring and summer. Holding wet corn can also result in blue eye mold development, which lowers the Grade but does not produce mycotoxins.

Harvest early: Harvest early and expect to dry the corn. Avoid holding wet grain before drying. Dry rapidly.

Watch dewpoint temperatures: Cooling the corn out of the field and after drying will be a challenge; watch the dewpoint temperatures. You will never cool the grain below the dewpoint. Ongoing temperature monitoring is key to successful storage. Recent developments in carbon dioxide monitoring have created another way to monitor spoilage; deteriorating organic matter always produces CO2 emissions.

Drying methods: Slower drying methods will require careful monitoring. There will be potential for additional spoilage before the grain dries. This would apply to both natural air and low temperature systems. You can increase drying speed in these systems by reducing the depth, but the tradeoff is having less grain in the dryer.

Bin dryer temperatures: Operate gas-fired bin dryers at temperatures above 120 °F, but not over 160 °F.

Management of pile grain: Temporary piles should be at commercial facilities, not on farms. Small piles spoil more rapidly than large ones. Management of pile grain is labor intensive, and often requires very short notice decisions about moving the grain. Larger piles are also easier to aerate.

Do not mix old and new crop grain in the same bin: The old crop has used much of its storage time and the new crop is still equilibrating moisture. Rotate stocks if you can. Be sure to separate the crop years and draw the center cores out of all bins, corn and soybeans alike.

Testing for toxins: Commercial grain handlers and processors should expect to receive grain with higher levels of damage and foreign material. Years vary in the production of mycotoxin issues. One way to track the situation in a given area is to collect a 10-lb daily composite (some grain from each of the deliveries in a day) for toxin testing. The USDA-GIPSA grain inspection agencies have the capability to test for the mycotoxins of most concern - aflatoxin, vomitoxin, zearalenone, and fumonisin. Toxin test kits are now simplified to the point where elevators and processors can do their own, but the USDA results provide a good benchmark. Results after 7-10 days should indicate whether there is a problem in an area. The composites also provide an opportunity to check the accuracy and completeness of on-site grading.

Grain handling safety: High volumes and wet corn, are the common ingredients for grain handling accidents, both entanglements and engulfments. Nothing is worth taking shortcuts on safety.

In summary, during wet falls, there will be large volumes of wetter and potentially moldy corn. Use test weight and visual mold presence as a measures of future storability. Identify in advance bins that will be kept for the long term, including possibly retained corn from last year. Separate crop years in storage, and scout fields for grain molds before harvesting. Low test weight and moldy corn are likely to go together. Dry quickly with as little wet corn holding time as possible. Once in storage, keep track of temperatures regularly and consider adding CO2 monitoring to your stored grain control process.