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Quality and Storage Challenges for the 2005 Crop

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Abstract
Management of the 2005 Iowa crop is presenting varied challenges for quality and storage. In southeast Iowa, drought-induced aflatoxin in corn is the primary issue. In NC-NW Iowa, larger than anticipated corn and soybean crops combined with large old crop carryovers and new demands of the ethanol industry have caused significant amounts of corn to be placed in outdoor piles. Management of aflatoxin and outdoor/temporary storage is presented. Statewide, rapid maturity and field drydown reduced soybean protein levels sharply compared to the previous 3 years.

Aflatoxin in Eastern Iowa
Conditions in eastern and southeastern Iowa as well as extensive areas of adjacent states to the south and east during the 2005 growing season have favored invasion of corn with Aspergillus flavus mold. This fungus has the potential under adverse conditions of drought stress and insect damage to produce toxic metabolites known as aflatoxins. Aflatoxins are potent toxins and experimentally are known also to cause cancer in some animals. Other feed grains, especially sorghum, milo and cottonseed can also be infected and support production of aflatoxins.

Aflatoxin is generally produced in standing grain before harvest. Aflatoxins are rarely produced in storage; corn moistures over 17-18% and temperatures over 60°F are required for the Aspergillus flavus fungus to thrive in storage. Aflatoxin, once produced, is quite stable to heat, milling, pelleting and many chemicals. While four specific aflatoxins are generally produced (designated B1, B2, G1, G2), the most frequent and toxic is aflatoxin B1.

In high-risk years, aflatoxin screening may be done at the elevator or where the corn is marketed. It may also be necessary to estimate aflatoxin levels for crop insurance or future animal feeding reasons. Rapid, on-site tests, such as test strips or the black light, can determine the possible presence of aflatoxin. However, these tests do not provide definitive or quantitative results. The toxins are produced inside the corn kernels and their presence can be determined only by analytical tests. Because aflatoxin levels vary greatly from kernel to kernel, sampling is the most critical step in determining actual levels of aflatoxin. An excellent and comprehensive discussion of aflatoxin and aflatoxin testing has been published by the USDA, Grain Inspection Packers and Stockyards Administration (USDA-GIPSA. The publication PM-1800, Aflatoxins in Corn, summarizes experiences with aflatoxin from other problem years (1983, 1988, 2002). Additional information on the growth and development of aflatoxin is also given.

How to sample corn for aflatoxin testing
Because aflatoxin does not occur uniformly through a field or lot of grain, the best approach is to make a composite sample consisting of subsamples from every part of a load, bin, or other unit of corn. Sampling recommendations vary by the type of lot to be sampled. In general, the smaller the sample size, the higher the variability. The USDA handbook cited above reports sampling errors of about 40% of the value for 10 lb samples, increasing to about 100-125% of the value for 1 lb samples.
Grain in Bins
The recommended procedure is to sample periodically from each load as the grain is being placed in the bin, combining these samples to obtain a composite corn sample of 10 lb or more. As a bin is being filled, take a 1 lb cut with a pan or coffee can from each load. Sample at about the middle of unloading. Combine the load samples, and take the entire composite sample to the laboratory that will perform the test. The lab will have the correct equipment for reducing sample size before grinding. Do not climb on the wagon or into the combine grain tank to collect samples; this is not safe. Sampling at bin filling is the best way to collect information for future feeding or marketing decisions.

An alternative is to sample with a power probe through a storage unit (five perimeter samples and one center sample for each 6 feet of bin height). Again take the entire composite sample to the laboratory. The objective in either case is to get about 1 lb of sample per 500 bushels. This is essentially the same sampling frequency used by USDA GIPSA for Official aflatoxin measurements of flowing grain as it is being loaded on ships for export. Most elevators loading railcars, barges and ships are equipped with diverter samplers, which take a 1 lb cut approximately every 500 bushels of grain.

Grain in Trucks or Wagons
Grain in trucks or wagons can be probed to collect at least 5 lb of sample per load. Take 5-7 probes per load (depending on the amount of grain per probe). The GIPSA sampling pattern for trucks is shown below. Larger containers, such as railcars or barges, have expanded probe sampling patterns; see the GIPSA mycotoxin handbook for probe sampling patterns to use in various situations.

Recognize that even a 5 lb sample is a loss of accuracy compared to a 10 lb sample. Smaller samples are a compromise for practicality reasons. However, a single truckload is far less grain than is in an entire bin; the error of analysis affects less grain and can be counterbalanced by the testing of multiple loads.

Since all sampling and testing procedures are subject to error, it is wise to identify for each load received (and accepted) the storage bin in which it was first placed. Maintain a composite sample for each bin by collecting a divided 1-lb (approximate) subsamples of each load in large container (eg 5 gallon bucket). When a bin is full, mix its composite and submit for laboratory analysis. Large bins may have several composites, representing layers. This procedure will provide a backup to screening at delivery and a more accurate inventory picture of the corn as it is in storage for future sale. Retention of this composite is the same as collecting the composite when filling farm bins.

Grain in the Field
In the field, sample individual fields or parts of fields separately. Fields that vary in cropping history, tillage practices, planting date, soil type, or hybrid can differ greatly in aflatoxin vulnerability. Sample a minimum of 10 to 30 locations within each field. To reach the same sampling frequency as testing grain in trucks, collect one sample (5-10 lb) for about every 5 acres. This would be about 2 ears per acre sampled. Use a GPS-based grid if the field is mapped.

Immediately dry ear samples to 12–14 percent moisture to prevent aflatoxin development during
transit or storage. High-moisture samples should be frozen and delivered to the laboratory in the frozen state. Dried samples maintain their quality best if shipped in cloth bags (as opposed to plastic bags). Do not use paper bags; there is too much chance of breakage. If the laboratory cannot shell the ears themselves, do not have them shelled more than a day in advance of delivering to the lab.

The USDA Risk Management Agency offers strip sampling as an alternative to random collection of ears. One strip is to be left per 40 acres with a minimum of three strips for fields under 10 acres and a minimum of four strips for the first 40 acres of larger fields. This will give approximately 1 lb of sample per 600 bushels of corn, at 150 bu/acre yields, more in smaller fields. The best method to sample strips would be to sample the grain from each strip after it is harvested, rather than attempting to identify a representative location within the strip to take an ear sample.

Field sampling is inherently much more variable than sampling of flowing grain because the geographic variation is added to the variation within a load or flowing stream. A field sample is best used to identify presence or absence of aflatoxin, as opposed to measuring specific levels. The most accurate way to estimate aflatoxin levels of a field is to sample every load of the grain as it is being delivered to an elevator or placed in a bin.

**How to test corn for aflatoxin**

Currently, two types of screening tests are available: blacklight tests and commercial ELISA-based test kits. The blacklight (also called ultraviolet light) test is a visual inspection for the presence of a greenish gold fluorescence under light at a wavelength of 365 nm (nanometers). The greenish gold fluorescence looks like a firefly glow. It is necessary to use a color standard (www.seedburo.com) to interpret black-light results because there are several types of fluorescence in grain. More than four glowing particles per 5-pound sample (before grinding) indicate a likelihood of a +20 ppb (parts per billion) level of aflatoxins. However, remember that this test is an initial screening for the presence of aflatoxin and the results should be verified by laboratory analysis. If there are less than four glowing particles per 5 lb sample, this does not guarantee that the sample is free of aflatoxins. In previous aflatoxin outbreaks, very few samples with over 20ppb of aflatoxin failed to have at least one glowing particle, but 30-50% of samples with 1,2 or 3 glowing particles tested negative for aflatoxin in a laboratory.

Commercial test kits with immunoassay or ELISA techniques are available for on-site tests for aflatoxin. Immunoassay analysis is based on the detection of specific proteins found in aflatoxins using antibodies to identify these proteins. The tests are very specific for aflatoxin with operator training and practice. Some tests determine only the presence or absence of aflatoxin; others can quantify, the amount of aflatoxin present. If a lot of corn is rejected based on the results of an immunoassay test kit, the results also should be confirmed by laboratory analysis. Test kits take a very small amount of ground grain; the entire sample should be ground before removing the subsample for the test kit. Do not subdivide 5-10 lb samples with a whole grain divider; this will cause frequent underestimation of aflatoxin levels and occasionally an alarmingly high test result.

GIPSA has evaluated several new qualitative quick test based on “lateral flow strip technology” (similar to pregnancy testing kits). These are immunoassay tests, but are much simpler (and faster) and can be used with minimal training. These are qualitative tests, but were very reliable in the GIPSA testing. The GIPSA evaluation program focuses on these as screening tests with
very low incidence of false negatives (20 ppb cutoff). If a positive is detected, the sample should be evaluated using a quantitative kit or laboratory reference method. The use of these kits is described in the GIPSA procedures (see web references below). The aflatoxin kits are approved by USDA-GIPSA (including the lateral flow strip kits).

Storage and receiving decisions based on either black light or test kit screening will contain some error. Composite samples of bins or shipments should be retained to determine actual levels and future risk exposure. For farm bins, use the procedure given above. For commercial grain handling, keep composite samples of 1 lb per load received according to the bin the corn was assigned to. For larger bins (more than 25,000 bu), consider keeping the composites in 25,000 bu increments with by date of receiving so that the order of filling is known. The more information available, the greater will be the management and handling options should a problem develop.

Corn samples can be tested for actual aflatoxin levels by official USDA-GIPSA or private laboratories. The Iowa State University Veterinary Diagnostic Laboratory analyzes samples submitted through a veterinarian. The site at the aflatoxin link contains a list of public and private laboratories equipped for aflatoxin analysis. Grain trade or other governmental needs (eg crop insurance) may require an Official aflatoxin test, done by a designated agency of USDA-GIPSA.

Storage Challenges
The 2005 corn and soybean crops, west of about Interstate 35 and north of Interstate 80 (the NW, NC, C, and WC crop reporting districts), are yielding higher than last year. These four districts contribute approximately 60 percent of the total Iowa corn and soybean production.

Entering the 2004 harvest, most commercial and on-farm storages were empty. Still, the crop overwhelmed the available storage capacity and large amounts of crops were placed in outdoor piles. Trade estimates place the amount of piled corn in Iowa at around 250 million bushels (out of a 1.4 billion bushel production) in 2004. There was a large premium for storage in the market, so the inevitable risks of outdoor storage seemed worth taking. Several complicating factors arose:

- Higher moisture (19 to 20 percent or greater in corn)
- Poor harvest weather (several rain and snow events through the fall and early winter)
- Strong desire by producers to get grain out of the field quickly.
- Ethanol plants became hesitant to accept corn with storage damage, because process yields decline sharply.

Significant amounts of 2004 corn, much of it with some amount of mold damage, are now in commercial storage, awaiting marketing opportunities from the 2005 crop.

This is not “mobile” because it has to be blended out slowly, not emptied all at once. Carryover 2004 corn is not suited for going back outside to a temporary pile.

- With the corn in storage, it is estimated that at least 500 million bu. of 2005 corn, and possibly up to 700 million bu, will be piled outside. This is at least double the
200-250 million bu. piled outside in 2004.

- Katrina slowed barge shipments and increased railcar turnaround times. The large difference between the Chicago Board of Trade price and local price (wide basis) in the affected crop districts is the consequence of large storage problems. Some firms are considering transferring grain to other areas of the country with more storage, but that will add to the marketing cost.

- Increasing local ethanol demand is requiring corn to be retained locally. The ethanol industry has been very clear about not wanting damaged corn, but few plants have extensive on-site storage.

- Early October weather accelerated maturation meant dry corn at harvest at the expense of perhaps 1 to 2 lb/bu of test weight.

- Increased soybean yields, above expectations, occupy covered storage. Soybeans are rarely piled outside.

- There is very little ability for the grain market to absorb additional out-of-condition corn.

If corn must be piled outside, or stored in non-traditional storages, such as sheds or tarped piles:

1. Make the grain pile on a solid surface or on packed ground in a high location with a slight slope for drainage. Recognize that gravel is hard to sort out of grain when it is picked up. Plastic under the grain helps, but may complicate grain handling.

2. Pile dry (less than 15 percent), clean, cold corn with test weight 55 pounds per bushel and higher. Lower test weight corn spoils more rapidly.

3. Do not mix crop years in any storage situation. The old crop likely has molded, and the new crop is not stable in moisture content. With grain piles, you have fewer moisture control options.

4. Consider pre-cleaning with a gravity or rotary cleaner.

5. Build the grain pile quickly, to avoid incorporating weather conditions and wet layers (from rain or snow) into the pile. Avoid piling slowly at harvest pace unless harvest pace will build the pile in two to three days without precipitation. Try to make the pile at the end of harvest season, when outdoor temperatures are lower.

6. Make the grain pile surface smooth, and of reasonably uniform depth. This reduces capture of snow, and promotes better airflow distribution.

7. Always pile over a fan and duct system. Updraft if the pile is not covered; downdraft if it is. Estimate 1 hp per 10,000 bushels (approximately 0.1 cubic foot per minute per bushel). However, any airflow will be helpful. The objective is to maintain equilibrium between grain and air temperatures.
8. Cool the grain pile as quickly as possible. It is often warm in early harvest, but warm grain will create air currents and spoil regardless of moisture. We have had very warm early fall temperatures this year.

9. Expect approximately a 0.5 percentage point increase in broken corn and foreign matter and a 3 to 5 percentage point increase in damage in uncovered grain piles, even under the best of conditions.

10. Covered grain piles are always preferred. Rain and melted snow do not run off; free water progressively wets corn to about 30% moisture as it moves down, so an uncovered grain pile, if it has been rained on, will always have a layer of moldy corn on top. An inch of rain will increase about 6-8 inches of grain from 15 to 30 percent moisture.

A pile inside a building (machine shed, hoop building) is essentially the same as an outdoor pile except that it is covered, and therefore can be kept longer (up to 6-9 months if aerated). An outdoor pile, even with aeration, should not be kept longer than 3-4 months.

**Storage Management**
Aeration is the most critical need for any type of storage. Aeration is a progressive process for controlling the temperature of grain. Aeration needs to be done in phases.

- **Phase 1: Fall Cool Down**
  - Check frequently (at least every two weeks)
  - Lower grain temperatures stepwise
    - October 40-45 degrees F
    - November 35-40 degrees F
    - December 28-35 degrees F

- **Phase 2: Winter Maintenance**
  - Maintain temperatures with intermittent aeration
    - January, February 28-35 degrees F

- **Phase 3: Spring Holding**
  - Keep cold grain cold
    - Seal fans
    - Ventilate headspace intermittently
    - Check frequently (at least every two weeks)
    - Warm when problems are seen or when grain is taken out.
    - Once you start to warm grain, warm the entire bin.
The following chart shows the grain temperatures that correspond to safe storage for corn and soybeans. As temperatures rise in the spring, moisture content for safe storage is lower.

Source: Purdue Univ.

**Web References**


http://www.extension.iastate.edu/Publications/PM1800.pdf

http://151.121.3.117/reference-library/directives/9181-2.pdf

http://151.121.3.117/tech-servsup/metheqp/testkit.htm

www.iowagrain.org