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The impact of the drought on grain quality and grain processing

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The drought conditions sharply cut the quantity of corn at a time when demand was increasing at a rapid pace. Drought also creates grain quality issues such as the threat of aflatoxin, low test weight, loss of soybean protein and oil, and other problems. Current data shows that some predictions were right and while others were not. The emergence of food safety as a major focus of all food/feed industries presented some new challenges as well, because aflatoxin is classified as an Adulterant by the US Food and Drug Administration (FDA).

General crop quality in the drought of 2012

Corn in many areas reached maturity earlier. by Labor Day weekend. Soybeans stopped and started with late rains, but pod count and seed size were established by Labor Day as well. This was a year to talk to crop insurance carriers early and often because some quality issues are covered; others are not. In general, quality issues that occur in the field and before any storage and handling occur are covered perils. Quality deficiencies are covered in crop insurance by deducting an additional percentage of production before settlement.

Corn

The primary general corn quality issues were expected to be low test weight/small kernels, significant mold pressure of all kinds in the many acres of downed corn and a general potential for aflatoxin at some level. Stalk strength was poor which contributed to downed corn.

Test weight-kernel size-composition

We expected kernels to be less dense and, therefore, lower in test weight. Low test weight from drought typically still means average protein and oil levels, which is good news for livestock feed. Expectation was not reality. Table 1 shows composition and test weight results from a series of strip trial plots that we have been analyzing every year. Test weight and protein were the highest in 2012 of the four years. Our explanation is that corn hybrids are very efficient at moving nutrients from the stalk to the ears, creating densely packed, but smaller kernels.

Table 1. Corn Quality 2009-2012

Year	Yield bu/a 15% M	Test weight lb/bu as-is	Moisture % as-is	Protein % 15% M	Oil % 15% M	Starch % 15% M	Density gm/cc 15% M
2009	194.1	54.0	25.6	7.6	3.6	61.1	1.244
2010	184.9	57.6	14.3	6.7	3.5	61.6	1.255
2011	207.6	58.7	16.8	7.2	3.6	61.2	1.271
2012	152.0	60.1	16.5	8.2	3.4	60.6	1.287

Four plots per year, same locations each year, 20-50 hybrids per plot.

Storage

The largest storage issue turned out to be mixed moisture; very dry in one part of a field and very wet in another. The first half of harvest had these problems. The corn was also very warm coming out of the field. Mixed moisture corn will not equalize quickly, certainly not in one pass through a dryer. Corn will segregate somewhat by moisture if it is drop filled in a bin; this means that both the high moisture and the fines will collect in the center. It will be very important to remove the center core right away; in large bins (over 50 feet dia), two removals would be advisable.

Corn was harvested with high outside temperatures, in the 80s and 90s, and was dried in the same conditions. This means corn in bins at much higher temperatures than normal. Early harvest corn will require at least two additional cooling cycles to reach the desired eventual temperature of 40F or below. Low temperature is the major control for grain spoilage after drying is complete.

A cooling cycle is moving a cooling front completely through a bin and is done when the average outside temperatures are 10-15F below the grain temperature. With 0.1 cfm/bu of aeration, this takes about 150 hours; with 1 cfm/bu, about 15 hours is required.. Because the shelf life of the grain is temperature dependent, it is important to begin these cycles as soon as a 10-15 degree temperature drop can be achieved. With higher initial temperatures, at least two additional (beyond normal) cycles will be needed. If the grain waits for a month to be cooled, the shelf life will be reduced and future spoilage is much more likely. Moisture variation means further reduces shelf life and creates more storage risk.

Review the yield monitor moisture output to estimate which fields are likely to be a future storage problem from moisture variations. Crop insurance will not cover quality issues after harvest. Table 2 gives the usual estimates of shelf life for moisture and temperature conditions. Reduce these by 50% if you had large moisture variations in the field.

Table 2. Maxiumum storage time (months) for corn and soybeans. Based on 0.5% maximum dry matter loss - calculated on the basis of USDA research at Iowa State University. Corresponds to one grade number loss, 2-3% pts in damaged seeds. Soybeans approximated at 2% lower moisture than corn.

	Corn (top) or soybean (bottom) moisture content						
Corn temp. ºF	**13% 11%**	**14% 12%**	**15% 13%**	**16% 14%**	**17% 15%**	**18% 16%**	**24% N/A**
	---- months ----						
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

Soybeans

The primary soybean quality impact of the drought was small and in some cases, flat and shriveled soybeans. In the drought of 1988, shriveled and wrinkled (shrinkled) soybeans occurred. A definition was created by USDA-GIPSA as wrinkled soybeans that do not fall through the small foreign material screen and are not considered splits. Price discounting will be at the discretion of the buyer, if at all. Shrinkled soybeans have a reasonably good protein and oil profile, but do not crack into pieces as required for efficient oil production at solvent extraction soybean plants. Expect residual oil levels in soybean meal to be higher than the normal 1%.

Soybean protein content was low because dry weather does not favor nitrogen fixation. Table 3 shows the same strip plot locations as in Table 1 for corn, for 2012 compared to the previous three years. Protein was reduced but oil was higher by almost an offsetting amount. If recoverable, this will be to the advantage of processors because oil is more valuable per unit than protein.

Table 3. Soybean Quality 2009-2012

Year	Yield bu/a 13% M	Moisture % as-is	Protein % 13% M	Oil % 13% M	Fiber % 13% M	Sum % 13% M
2009	58.7	13.7	34.7	18.5	4.9	53.2
2010	58.7	10.5	35.5	18.5	4.8	54.0
2011	65.9	10.5	34.2	18.4	4.9	52.6
2012	52.5	8.7	33.9	19.9	4.8	53.8

Four plots per year, same locations each year, 10-40 hybrids per plot.

Aflatoxin in 2012

Aflatoxin, a toxic secondary metabolite of *Aspergillus flavus*, occurred this year because of the hot, dry weather persisting from pollination through grain fill. The Aug. 2 issue of the ICM Newsletter explained the biology and conditions required for aflatoxin. Preharvest scouting for the fungus was the best way of advance warning; the actual toxin is not formed until the corn is below 30% moisture, and then only in warm conditions during the drydown period. Aflatoxin is adjusted for crop insurance in the field, not after the crop has gone into the bin. Aflatoxin testing has a 25-50 percent sampling error; only a USDA-RMA approved third-party lab can determine aflatoxin in crop insurance samples.

Market impacts of aflatoxin

The general tolerance for aflatoxin in interstate commerce is 20 parts per billion. Aflatoxin is classified as an adulterant in U.S. Food and Drug regulations. The most sensitive industries for aflatoxin are dairy (because of pass through to milk), pet food (pets are very sensitive to aflatoxin) and ethanol/processing plants. The toxin concentrates threefold in the feed/food co-products such as distillers grains. Some DDGS may have to be marketed selectively to large animal feeding. Table 4 shows the recommended feeding levels and the milk tolerance.

Table 4. Recommended feeding levels and milk tolerance.

Commodity	Amount
Corn for lactating cows	20 ppb
Milk	0.5 ppb
Corn for breeding beef/swine/poultry	100 ppb
Corn for finishing swine >100 lb	200 ppb
Corn for finishing cattle	300 ppb

Source: Iowa Beef Center

Expect grain buyers, both elevators and processors, to be monitoring for aflatoxin. If the overall level of aflatoxin in a region does not approach the 20ppb limit, then the buyer may elect to test composite samples of all loads in a period (half-day, day, etc) to verify that, on average, the grain is acceptable. If the composites show a regional or local issue, then individual load testing may be needed. This is time consuming and costly.

The FDA approved a temporary blending policy for aflatoxin in Iowa and surrounding states. This policy was released September 19 by the Iowa Department of Agriculture and Land Stewardship. The key point is that if corn is blended to reduce aflatoxin in the resulting blend to useable levels, the blended corn must be marketed with **documentation of aflatoxin levels** and intended use. Corn above 500 ppb cannot be blended at all. Producers accepting a crop insurance settlement for aflatoxin are subject to this blending policy. Corn that has received a crop insurance settlement for aflatoxin should not be returned to the general market without documentation.

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From previous experiences in 1983, 1988 and 2005 we expected that aflatoxin would be a steady problem in 2012. In 1983 and 1988, with similar weather conditions, the average aflatoxin level of Iowa corn was right at the 20 ppb limit. Incidence was actually less than expected. As yet unpublished USDA-GIPSA reports of aflatoxin through October indicates less than 20% of Iowa corn with more than 20 ppb. Incidence varies across Iowa, but overall, the 2012 incidence was about half that of 1988 and 1983. The average of Iowa corn will likely be less than 20 ppb in 2012, which will reduce the need for individual load testing. Monitoring of averages will be needed through the year.

The 2012 data looks better than expected, but risks remain:

- Sensitive users will have to remain vigilant.

- Producers feeding their own, and therefore less blended, corn should get a good test before use.

- Grazing animals in harvested fields carries risk; the corn will get eaten first.

- Wet corn (over 17% moisture) that was held before drying, or that was dried in heated-air bin dryers using temperatures below 120F may show increased aflatoxin when taken out of storage.

A list of testing labs, including the USDA-GIPSA agencies serving Iowa, is at www.iowagrain.org. The USDA - Risk Management Agency has posted a fact sheet on aflatoxin testing for insurance purposes. The ICM Newsletter has two articles specifically about sampling and testing for aflatoxin.

Aflatoxin levels must be above 20 parts per billion before insurance payments are impacted. The important points for crop insurance are 1) that crop insurance must be called before harvest; no settlements will be made for corn already in storage; 2) that producers getting a settlement for aflatoxin must direct the corn to an approved use for the level present, with documentation of test results and 3) that all measurements, samples, and testing must be done under the supervision of the adjuster. Settled corn must be directed, with documented proof, to an approved feed use. Corn settled for aflatoxin should not be offered back to the general market without notice; the new food safety legislation (Food Safety Modernization Act) creates significant liability if a downstream issue can be traced back to a production source.

Corn laying on the ground can have more toxin risks than just the aflatoxin, for which there is general potential. This corn should be tested for the series of mycotoxins of most concern – aflatoxin, vomitoxin, fumonisin and zearalenone. Testing laboratories are listed on the Iowa Grain Quality Initiative website; the Iowa State University Veterinary Diagnostic Lab will also test samples for mycotoxins.

Aflatoxin and grain storage

Aflatoxin is not removed by drying or freezing, but does not usually increase in storage. *Aspergillus flavus* is not a strong storage mold; it is quickly crowded out by others. Storage at 17 percent moisture and above, with temperatures above 70F, could cause an increase in aflatoxin, but normal grain cooling and drying practices will be effective in controlling further production. Natural air, stirred and other bin drying methods will work if the wet grain is not held warm awaiting drying. Evaporative cooling (check the dewpoint temperatures) normally keeps natural air and low temperature drying systems cool enough.

Bin dryers operated at medium temperatures (below 120F) can create issues. The optimum temperature for aflatoxin production is 75-95F with moistures greater than 17 percent. A bin dryer operating with input air below 120F will "store" the grain during drying at warm temperatures. If the bin is full, drying times of four to six days are not uncommon. In this case, grain already containing the *Aspergillus* fungus can experience increased aflatoxin levels.

The correction is to increase drying air temperatures beyond 120F. Some bin drying systems with rapid stirring systems can go as high as 160F; others with less grain circulation may be limited to around 140F. Half batches will also help; shallower grain depth will increase airflow and cause less grain be held at higher moistures. It would be better in this case to dry two half batches instead of one full batch.

High temperature batch and continuous flow dryers are not susceptible to this problem, but wet corn should be held in high airflow wet holding (to maintain cold temperatures) or in the field. As an example, today's conditions of about 80F and 30 percent relative humidity will hold aerated wet grain at about 45-50F because of evaporative cooling of dry air. This is below the growth conditions for *Aspergillus flavus* mold, although in time other more temperature resistant fungi will grow at those temperatures. Low temperature-natural air drying will also work under these conditions because the wet grain will not be warm enough to sustain the fungus.