Harvesting, Drying, and Storing Corn

Field-drying corn is usually the most economical approach for Midsouth growers.

Data from Mississippi and Louisiana show the field-drying rate from maturity, or black layer, occurs at about 0.6 percent per day until the grain reaches 15 percent moisture. Drying rates as high as 1 percent per day moisture loss were measured under more ideal field-drying conditions and for the higher initial grain moisture contents. Corn grain physiological maturity (black layer) usually occurs at about 30–33 percent moisture content and depends on variety, weather, soil types, moisture, and production practices.

Corn will shell with a combine at about 30 percent moisture content with minimal kernel damage. Axial-flow combines will shell corn at moisture contents as high as 35 percent. Ease of shelling at higher moisture contents depends on the variety.

A variety that matures on August 1 at 33 percent moisture would be ready to harvest in 8–13 days at a moisture content of 25–28 percent. Harvest could begin on August 9 with farm drying or accepting the elevator dockage for excess moisture. Field-drying to 15 percent moisture would push the harvest date to September 1.

Combine and weather losses would also likely be greater for the delay in harvest but would not normally offset the additional cost of drying and handling grain on the farm with low corn prices. The advantages of gaining early-market premiums, storage and improved market flexibility, reduced risk of severe weather, aflatoxin reduction, early fall tillage, improved management of the farming operation, scheduling trucking, and uninterrupted harvesting must help to offset the costs of constructing handling, drying, and storage facilities.

Field losses increase as field-drying occurs. Data on the amount of weather losses that occur in the Midsouth are not available. Most years, growers can get the crop out of the field early enough that lodging is not a major problem. Midwest data indicate weather losses increase at a rate of about 1–2 percent per month of exposure during their conditions in October, November, and December.

Data from the Midwest indicate combine losses are least when corn reaches 26 percent moisture (about 1–3 percent losses are typical). Combine losses increase as the grain moisture dries. Losses of 10–15 percent are fairly common with corn at 15 percent moisture. These losses occur because of whole ears snapping off the stalk and falling to the ground as well as shelling of corn in the header.

Corn was harvested at weekly intervals at 10 locations during a 3-year study (1998–2000) in Mississippi. Zero to 5 weeks of field-drying (August and September) were achieved for the plots harvested at each location. Combine efficiency data collected from the 10 fields show harvester losses averaging about 12 percent (all harvest days, all moisture contents, all locations) for both weather and machine. Average yield for the 10 locations was 159 bushels per acre and ranged from 108 to 202 bushels per acre. Only 3 of the 10 locations showed any trend for increased losses with delayed harvest (field-drying).

Combine condition and adjustment was believed to have a greater effect on harvest efficiency than moisture content in at least four of the ten fields studied. These data were taken in years with near ideal field-drying conditions and no major weather or insect events affecting harvest.

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There is no fixed moisture percentage to initiate harvest. The Midsouth growers' belief that initial corn harvest should begin as the corn field-dries to 18–20 percent moisture content may be well founded or folly. Midwest data strongly suggest beginning harvest at 25 percent moisture content, based primarily on long-term weather and machine loss data.

Growers must decide when risks such as weather, insect and varmint damage, exposure to fungi and molds producing aflatoxin, increasing combine losses, seasonal price fluctuations and possible loss of early market premiums, and delays in fall tillage offset the benefits of free-crop drying (field-drying), on-farm drying, and other management advantages that may be unique to their farms. There is no documented significant risk that could have been avoided by initiating harvest before corn field-dried to 15 percent moisture content, except for years when extreme weather events occurred (for example, near continuous rainfall during September and October 2009, hurricanes Katrina and Rita in 2005, and Hurricane Ike in 2008). More field studies should be carried out over a wide range of weather, field, and machine variables to have a basis for these decisions.

Cost of on-farm drying facilities. Drying off 10 percentage points of grain moisture (25–15 percent) requires removing 7.47 pounds of water. It will require about 15,000 Btu of heat in a drying system with the normal efficiencies in the Midsouth (about 2,000 Btu per pound of water removed). Dryer manufacturers in the Corn Belt quote efficiencies of as low as 1,400 Btu per pound of water removed for continuous flow dryers to as high as 2,100 Btu/lb of water removed in a bin-batch drying system. Keep in mind these systems are used where harvest occurs in cooler and dryer parts of the season.

One gallon of LP gas contains 95,475 Btu of heat. Therefore, 1 gallon will remove about 10 percent moisture from 6 bushels of corn. With LP gas costing $2/gal, it would cost about $0.32 per bushel to dry. Add to this about 1 to 1.5 cents per bushel for electric energy for a total drying energy cost of about $0.33 per bushel. Labor costs are typically $0.02 per bushel for handling corn and managing the dryer. You should consider rising energy costs when estimating drying cost.

Dryers and handling facilities require large capital investments and therefore must have large annual volumes to justify their cost. A typical 500 bu/hr continuous flow dryer with wet holding and cooling bins and handling equipment will cost about $100,000. Operating this facility 24 hours per day for 20 days would dry 240,000 bushels of grain (or the equivalent of 1,600 acres of 150 bu/ac corn). Principal and interest costs over a 7-year period with 5 percent interest would cost $0.07 per bushel. Cutting the volume of grain dried in half by running only 10 days of 24 hrs/day or running only 12 hrs/day for 20 days will double the cost per bushel ($0.137 per bushel) for principal and interest.

Higher level management skills are required to get the high use levels needed and to operate a drying facility. Matching combine capacity to the crop and on-farm dryer is a must for maximum efficiency. If 1,200 acres of 100 bu/ac grain are to be cut and farm-dried in the drier above in 12 days, only one machine harvesting 100 acres per day is needed. This will match the dryer's capacity when harvest is first started if the dryer is operated 24 hrs/day removing 10 percent moisture. As the crop field-dries, more and more slack time on the dryer will occur. But if you plan to dry all the crop through the dryer, don't rush out and buy another combine. And if yield is more than 100 bushels per acre, just be patient and operate the combine fewer hours per day or sneak a load or two directly to the elevator.

This is a useful formula for determining an estimate of harvesting capacity:

acres/hour = header width (ft) x speed (MPH) / 10

This formula considers a machine efficiency of 83 percent (percent of time on the row), which is typical for a corn harvesting operation.

Contract drying: consider the risks. Contract drying can be a viable option depending on the price of drying, whether the charge is on wet or dry bushels dried, and who assumes the risks of overdrying, aflatoxin contamination or other grain spoilage, and the transportation inconvenience. Drying costs of $0.30 to $0.35 per bushel for energy and $0.15 per bushel for the facility and labor ($0.40 to $0.50/bu total) are reasonable on a dry bushel basis and 10 percent moisture removal. Most operators will charge up to 25 percent more for a profit to them. Less moisture removed should mean lower charges, since less energy and time are required to dry the corn. Basing the charges on wet bushels in will increase the cost to the grower by about 12 percent for a 10 percent moisture removal.

A clear understanding of the risks, agreement of who is responsible for them, and a sampling procedure for grain quality and moisture before and after the contract drying are advisable.

Shrinkage is a fact of life when corn dries. There is no getting around the fact that it takes 63.47 pounds of corn at 25 percent moisture to make a 56-pound bushel of corn at 15 percent moisture. This requires drying off 7.47 pounds of water in the process. This loss is shrinkage and occurs wherever the corn is dried in the field, bin, or elevator. This amounts to 11.76 percent loss of weight that becomes a part of moisture dockage, but this is often overlooked when field-drying or with on-farm drying systems. Therefore, a 10 percent moisture differential will amount to a 12 percent loss of weight.

Bushels of dry grain may be computed from the wet grain harvested if a reliable moisture content is available by this formula:

dry weight = wet weight x (100 - wet % moisture) / (100 - dry % moisture)

For example, if 1,000 bushels of dry grain at 15 percent moisture is desired from 25 percent moisture grain, it would require 1,134 bushels of wet grain. 1,000 = wet weight x (100-25)/(100-15). So 134 bushels of shrinkage occurred.

Elevator dockage takes a larger bite when corn prices are higher. Dockage rates for our area are generally in the range of 2.5 percent per 1 percent grain moisture increase above 15 percent. Dockage must cover shrinkage losses, drying facility and energy costs, labor, and risk for the grain that is handled and dried. Drying and handling costs are the same regardless of the price of the grain. Shrinkage and risks costs do increase with an increase in grain prices.

An example of a dockage chart for different moisture contents is given in the following table along with the market values once shrinkage is taken out. Follow the example and note the dockage for 25 percent moisture corn is costing the grower $0.45 per bushel with prices at $3 per bushel and $0.60 per bushel when prices are $4 per bushel. The extra $0.15 per bushel per $1 of value can only be for the higher risk and elevator's profit above the cost of drying and shrinkage. **As corn prices increase, it is more profitable for growers to install on-farm handling and drying facilities.**

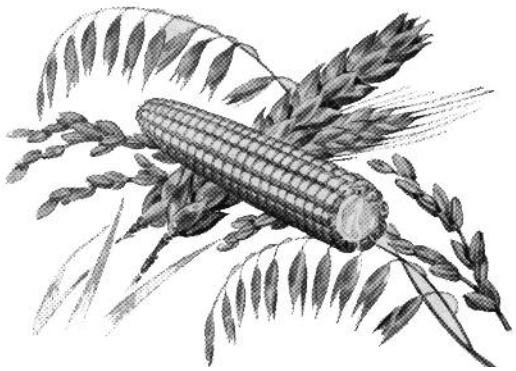
Table 1. Corn drying dockage.

				Market Value/100 Dry BU @ $/BU				
% Moist	Wet BU	Dockage %	Market BU	$2.50	$3.00	$3.50	$4.00	$4.50
28.00	118.06	32.50	76.69	199.22	239.06	278.91	318.75	358.59
27.00	116.44	30.00	81.51	203.77	244.52	285.27	326.03	366.78
26.00	114.86	27.50	83.28	208.19	249.83	291.47	333.11	374.75
25.00	113.33	25.00	85.00	212.50	255.00	297.50	340.00	382.50
24.50	112.58	23.75	85.84	214.61	257.53	300.46	343.38	386.30
24.00	111.84	22.50	86.68	216.69	260.03	303.37	346.71	390.05
23.50	111.11	21.25	87.50	218.75	262.50	306.25	350.00	393.75
23.00	110.39	20.00	88.31	220.78	264.94	309.09	353.25	397.40
22.50	109.68	18.75	89.11	222.78	267.34	311.90	356.45	401.01
22.00	108.97	17.50	89.90	224.76	269.71	314.66	359.62	404.57
21.50	108.28	16.25	90.68	226.71	272.05	317.40	362.74	408.08
21.00	107.59	15.00	91.46	228.64	274.37	320.09	365.82	411.55
20.50	106.92	13.75	92.22	230.54	276.65	322.76	368.87	414.98
20.00	106.25	12.50	92.97	232.42	278.91	325.39	371.88	418.36
19.50	105.59	11.25	93.71	234.28	281.13	327.99	374.84	421.70
19.00	104.94	10.00	94.44	236.11	283.33	330.56	377.78	425.00
18.50	104.29	8.75	95.17	237.92	285.51	333.09	380.67	428.26
18.00	103.66	7.50	95.88	239.71	287.65	335.59	383.54	431.48
17.50	103.03	6.25	96.59	241.48	289.77	338.07	386.36	434.66
17.00	102.41	5.00	97.29	243.22	291.87	340.51	389.16	437.80
16.50	101.80	3.75	97.98	244.95	293.94	342.93	391.92	440.81
16.00	101.19	2.50	98.66	246.65	295.98	345.31	394.64	443.97
15.50	100.59	1.25	99.33	248.34	298.00	347.67	397.34	447.00
15.00	100.00	0.00	100.00	250.00	300.00	350.00	400.00	450.00

The table is calculated assuming that 100 dry bushels of corn will be the result of drying corn at various moisture contents from 28 to 15 percent. The wet bushels shown is what is required to produce 100 dry bushels at 15 percent moisture content. Dockage is calculated at 2.5 percent for each 1 percent moisture above 15 percent. The marketable bushels are calculated by multiplying the wet bushels for a given field moisture by 100 minus the total dockage percentage.

Market value per 100 bushels is computed for several market prices. To get a "true"dockage cost per bushel, simply take the difference in market value for the two moisture contents in question and divide by 100. For example, 109 bushels of corn at 22 percent moisture and $4/bushel is worth $359.62 after dockage. The same corn dried down to 15 percent moisture (whether field-dried or dried in bins or the elevator) is worth $400 with zero dockage. The difference is $40.38 per 100 bushels, or $0.40 per bushel.

Weather and increased combine losses may reduce yields significantly more than the 10.1 percent lost to dockage after you take away the moisture that would be lost no matter what method of drying you use. As corn price increases, dockage becomes greater per bushel.



Quick Facts and Frequently Asked Questions

about Aflatoxin and Corn Harvesting, Drying, and Storage

How much is a bushel?

- 1 bushel is 1.25 ft^3.
- 1 bushel of shelled corn at 15.5 percent moisture weighs 56 lbs.
- 1 bushel of ear corn (shelled corn equivalent) occupies 2.5 ft^3.
- 1 bushel of ear corn at 15.5 percent moisture weighs about 70 lbs.
- 1 bushel of shelled corn contains about 80,000 kernels.

What is aflatoxin?

- Aflatoxin is a toxin produced from a fungus common in the environment and most agricultural commodities.
- Presence of the fungus does not necessarily mean aflatoxin has, or will, develop.
- Aflatoxin is one of the most deadly, cancer-causing compounds formed in nature.

Under what conditions is aflatoxin most likely to develop?

- Aflatoxin development can usually be associated with stressed crops.
- Stress may be water, heat, insect damage to the plant, and the like.
- Temperatures between 85 °F and 105 °F.
- Higher nighttime temperatures.
- Relative humidity between 80 and 100 percent.

What aflatoxin levels are acceptable in feed rations?

- Less than 300 parts per billion (ppb) for finishing beef.
- Less than 200 ppb for finishing swine more than 100 lbs.
- Less than 100 ppb for breeding beef or swine or mature poultry.
- Less than 20 ppb for corn intended for humans, dairy, or poultry.
- Less than 20 ppb when you do not know destination at first sale.

What is a "part per billion"?

- 1 penny in $10,000,000.
- 1 second in 31.709 years.
- 1 oz of water in a swimming pool of water that is 100 ft x 200 ft x 5.23 ft.
- 1 kernel of corn in 12,500 bushels.
- 20 ppb is equivalent to two kernels' weight in a 1,250-bushel load of corn.

How do I clean aflatoxin-contaminated equipment?

- Clean grain and debris from combines and hauling and handling equipment.
- Clean all debris and chaff from grain bins and handling equipment.
- Clean beneath floors and around the bases of grain bins.
- Wash bin walls and floors with a 1–2 percent chlorine solution.
- Wash cleaned equipment with high pressure hot water or steam cleaning device.
- Caution: following chlorine solution application, wash all metal components thoroughly. Chlorine is extremely corrosive to metal, especially galvanized bins.

What can I do with aflatoxin-contaminated corn?

- Federal law requires an end user to be identified before grain can be moved across state lines when contamination is more than 20 ppb.
- You may identify a feedlot or other market that can blend with non-contaminated feeds so a total ration mix is within FDA acceptable levels, sell at a negotiated discount, and provide freight line proper certification.
- Grain preservatives such as propionic acid (calcium propinate) stop the fungus growth but do not reduce existing levels of aflatoxin.
- Fumigation with anhydrous ammonia can detoxify aflatoxin, but it is not FDA approved. It discolors the grain, requires special handling, produces toxic compounds that are major safety concerns, and corrodes equipment. No commercial markets accept ammoniated grain.
- A feeder may use hydrated sodium calcium aluminosilicate (HSCAS, an activated clay) to reduce aflatoxin toxicity.
- Alcohol production plants can use contaminated corn. However, they are reluctant to do so because the plant must then be decontaminated and they must dispose of, or detoxify, the by-products that would normally be sold as animal feed.

How do I test for aflatoxin?

- Semi trucks should be sampled by pulling approximately 1-lb samples from each of 10 sampling points spaced similar to a "double-five" domino dot pattern. These 10 samples are blended and sent to an approved lab. Reliable testing can come only from a truly representative sample.

- Ultra violet lights (UV, sometimes referred to as "black lights") cause fluorescence from the presence of the fungus to be visible and is not a positive indication that aflatoxin is present.
- Send representative grain samples to the State Department of Agriculture Grain Inspection or state chemistry labs for analysis.

Why do two elevator tests detect high and low aflatoxin within the same load?

- In aflatoxin-contaminated corn, only about 1 kernel in 1,000 actually contain aflatoxin. That's about 80 kernels/bushel.
- One kernel may contain up to 400,000 ppb aflatoxin.
- One load represents a wide range of field conditions, insect pressures, fertility levels, and drought and heat stresses.
- For a true sample, both numbers of sampling locations and size of samples must represent the load.
- There is more error in the mechanical sampling and "probability" than in the actual analysis procedure.

How can I minimize aflatoxin at the farm level?

- Plant at recommended planting dates for the area.
- New hybrids being developed may be more resistant to aflatoxin development.
- Choose hybrids carefully.
- Control insects.
- Minimize drought and heat stress with irrigation.
- Begin harvesting when grain field-dries to 25–28 percent and dry immediately.
- Harvest only what can be dried or delivered to market or elevator within 24 hours.
- Corn high in moisture (greater than 18 percent) and harvested at higher temperatures (greater than 80 ºF) should be dried and aerated immediately.
- Harvest field-stressed areas separately (drought- or heat-stressed, poorly drained areas, outside irrigation pivots, severely eroded areas).
- Adjust combine for a clean tank sample, low mechanical damage, and low losses.
- Operate the combine cleaning fans at maximum possible speed and cleaning.
- Slow the combine ground speed to decrease the amount of grain being cleaned at any time.
- Clean combines and handling equipment after harvesting high moisture grain and after rainfall that may wet grain and cause it to spoil.
- Clean exterior of combine daily to minimize chaff and dust that may contain fungal spores.

Are grain cleaners effective in reducing aflatoxin levels?

- Central grain cleaners are effective in removing foreign matter and light kernels.
- These materials are sometimes high in aflatoxin but may not be the main source of contamination.
- Central cleaners are very slow when cleaning moist grain.
- Cleaning rate and effectiveness is enhanced by drying before cleaning.
- A well adjusted and operated combine is often as effective as a central cleaner at reducing contamination levels.
- Consider only central cleaners when attempting to salvage contaminated grain that has been dried and stored.
- Avoid operators of grain cleaners who are playing the probabilities game when trying to reduce aflatoxin levels, betting that sampling procedure may miss previously detected contamination.

What are the safe long-term storage conditions for corn?

- Clean and disinfect the bins before putting any grain in them.
- Treat for insects as the bin is filled.
- Keep corn at temperatures below 60 ºF.
- Keep corn moisture content below 13 percent.
- Aerate when ambient and grain temperature differ by 10 ºF and RH is less than 65 percent.
- Avoid re-wetting grain without operating a stirring device. (Swelling grain will cause bin walls to fail.)
- Inspect the grain for problems regularly.

Additional Information

For more information about grain processing, contact

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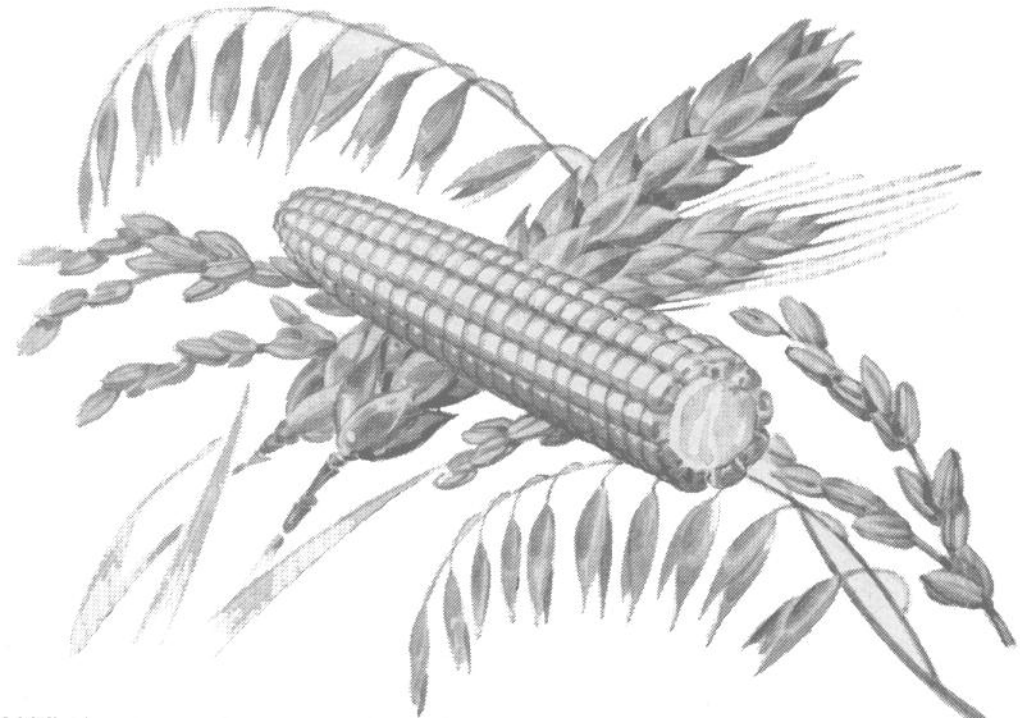

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Publication 2285
Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. MELISSA J. MIXON, Interim Director (POD-05-10)