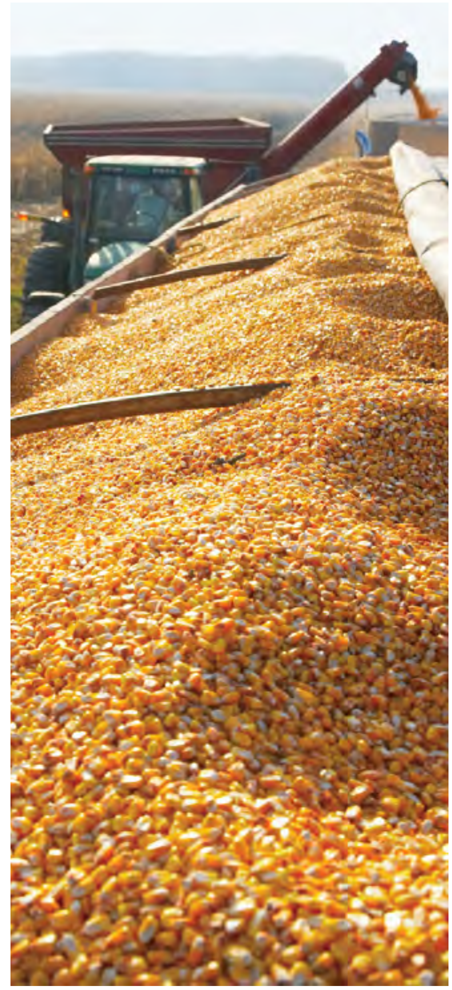
Improving corn drying efficiency

In some years, energy bills for corn drying can rival costs for fuel used to plant and harvest the crop. Studying basic concepts of heated air and natural air drying—as well as understanding factors affecting in-field drying—helps to effectively control corn drying energy costs.



Basic drying principles

Corn is hygroscopic material: it allows moisture to enter and exit the kernels depending on surrounding conditions. The moisture content of corn kernels comes into equilibrium with the temperature and relative humidity of surrounding air.

In-field drying

After corn is physiologically mature, a black layer forms at the tip of the kernel, preventing further exchange of nutrients and water between the kernel and cob. After black layer formation, temperature and relative humidity of surrounding air are the main contributors to in-field drying. However, plant morphology also is important. A tight husk restricts air exchange with corn kernels and controls how much of the ear tip is left exposed.

Limited field-drying data suggest daily drying rates may average 1.0% in mid-September, 0.7% in late September, and 0.5% in early October. More importantly, there is wide variation among seasons due to weather conditions. Days early in the harvest season (e.g., the first week of October) with a strong, dry wind and air temperatures in the mid-70s°F can produce in-field drying of 1% per day. Conversely, corn moisture content in the field can remain unchanged for periods of two weeks or longer if weather is cold and wet. A plan for drying grain artificially is necessary during years with inadequate field drying conditions. In addition, evaluate stalk strength and standability before leaving corn to dry in the field late into the season.

Select earlier maturing hybrids rather than full maturity

Consider selecting an earlier maturing corn variety adapted for your location rather than full maturity. Figures 1 and 2 show moisture content and yield for corn hybrids identified as either full or early maturity by seed companies for several regions as tested by the Iowa Crop Improvement Association and Iowa State University. Early-season hybrids were drier at harvest and did not reduce yields.

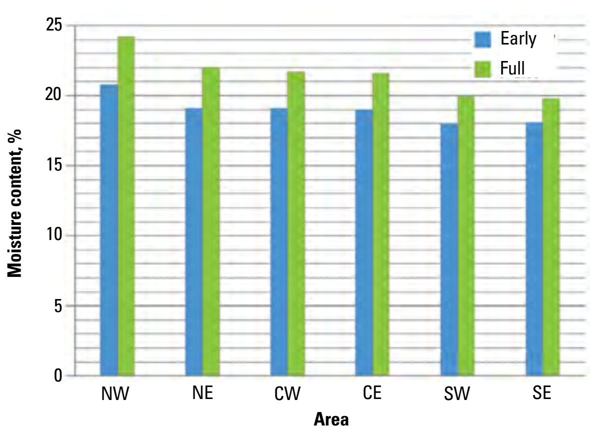


Figure 1. Corn moisture content at harvest of full- and early-season varieties (approximately 5 days earlier or more) in Iowa Crop Improvement Association and Iowa State University yield tests, 2009–2010. Early-season hybrids averaged 2.5% drier at harvest.

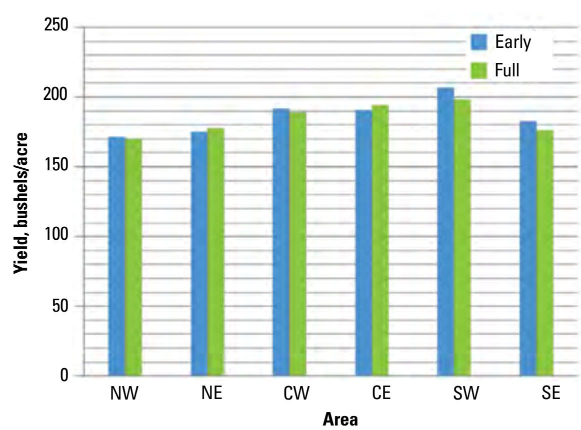


Figure 2. Corn yield averages of full- and early-season varieties (approximately 5 days earlier or more) in Iowa Crop Improvement Association and Iowa State University yield tests, 2009–2010.

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How artificial corn drying occurs

Corn kernel moisture content comes into equilibrium with surrounding air conditions during the drying process. Figure 3 shows this equilibrium relationship. For example, corn exposed to 40°F air at 45% relative humidity dries to 12% moisture content. In low-temperature drying systems, in which corn dries over a matter of days or weeks, moisture within the kernel has ample time to migrate to the kernel's surface and the whole kernel dries uniformly.

In high-temperature drying systems, kernels are exposed to high-temperature air with very low relative humidity over a matter of minutes. When air is heated to these high temperatures, relative humidity becomes quite low, resulting in some over-drying of corn — when hot air rushes past the kernel surfaces. Interior parts of the kernel or whole kernels closer to the airflow exit remain wetter than desired. Often outer parts of the kernel or whole kernels closer to the dryer's high-temperature air plenum are over-dried, while after high-temperature airflow stops, heat retained in kernels and continued moisture migration allow additional drying to occur with unheated cooling air. During cooling operations or storage, wetter portions of the grain (either interior parts of kernels or whole, wetter kernels) approach equilibrium with drier portions of the grain. Understanding how kernels dry helps explain energy efficiency concepts described in high- and low-temperature drying publications in this farm energy series.

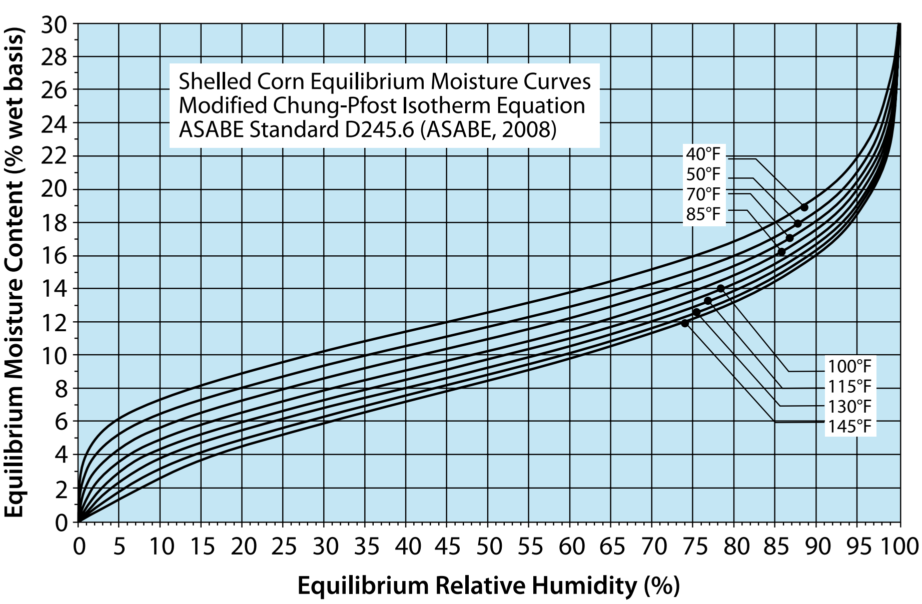

Figure 3. Equilibrium moisture content of shelled corn with air of various relative humidity and temperature.


Holding corn 'wet and cold'

Over-drying in the fall often leads to extra energy consumption. Corn quality generally can be maintained through Iowa's fall and winter weather if corn is dried to about 17% moisture content before storage. Temperatures below 40°F greatly slow mold growth in the grain. If corn will be fed locally to livestock before grain warms in the spring, avoid drying below 17% moisture content, as animals often prefer slightly wet grain.

To successfully hold grain wet and cold, use proper grain management practices, including cooling grain in storage as quickly as possible after harvest, checking grain condition weekly for moisture migration problems, and using fan cooling as necessary if any heating is detected (often at the top center of the storage bin). Because mold growth will increase as air and grain temperatures rise, grain held wet and cold through the winter must be fully dried before warmer spring and summer weather arrives for longer-term storage. Note that microbial degradation still slowly affects grain quality at 17% moisture content. Even though drying is completed before warm weather, periodically monitor grain, as a portion of its useful storage life will have been consumed.

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