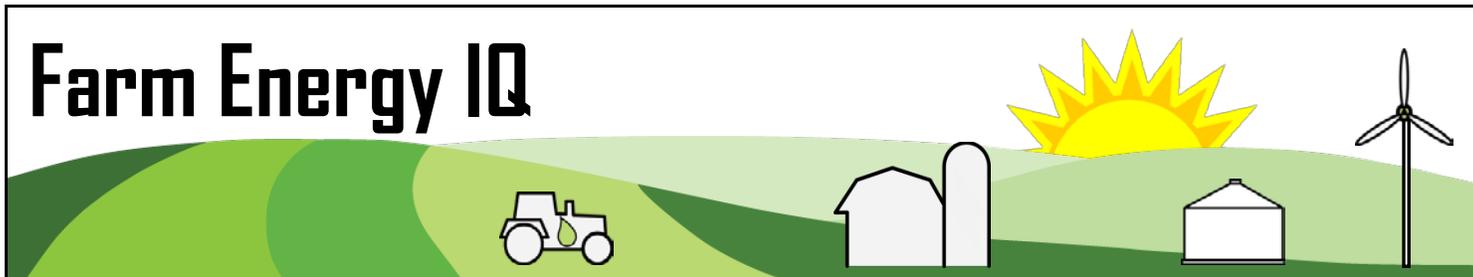


Farm Energy IQ



Saving Energy in Grain Drying

INTRODUCTION

Although grain drying accounts for less than 10% of overall energy use in U.S. agriculture, on farms that dry corn, soybeans, and cereal grains, more energy may be used for drying these crops than is used to grow them. In the variable climate of the Northeast U.S., some years may be dry enough so that crops need little or no supplemental drying after harvest while, in other years, wet fall weather may lead to significant energy use for drying crops. Energy use in grain drying relies on two primary factors: harvest conditions (moisture) and efficiency of the drying process.

HARVESTING PRACTICES

Before harvest begins—in fact before the crop is planted—particularly with corn, selecting a hybrid with good standability and faster drydown in the fall can be beneficial for reducing drying energy use. Farmers can stagger maturities and planting dates to aid in managing grain moisture over various fields. Finally, selecting the earliest maturing hybrids and varieties, without sacrificing yield, can help to reduce supplemental drying energy.

At harvest time there are numerous field practices which can increase the efficiency of supplemental drying. For example, dust and fine particles, which can be minimized with proper harvesting, are large contributors to drying process inefficiency. Where practical, reduce the particulate matter left in the harvested grain by increasing cut height (except on soybean and other crops with grain along the length of the stem). This will also reduce the energy needed to run the combine. Threshing fan speed should also be kept as high as practical to minimize fine particulates. For corn, late harvest and consequently lower moisture content reduces the amount of fines because less aggressive shelling needs result in less kernel damage. However, for fields with varying soil properties, or after long periods of plant stress, it may be difficult to set the combine properly to reduce fines and other matter because the properties of seeds harvested throughout the field will vary. In addition, late harvesting may result in the combine missing more lodged stalks. Severe drought stress may also make an earlier harvest imperative, due to reduced standability. If this happens often on a particular farm, one possible solution is to harvest early and invest in a grain cleaner through which crops can be processed before storage or supplemental drying. Where a moderate problem exists with fines or high moisture at harvest, a distributor installed in bins can reduce the accumulation of fines in any one place, to an acceptable level.

SUPPLEMENTAL DRYING PRACTICES

In supplemental drying, higher temperatures are generally more energy efficient than lower temperatures because the higher temperature air has a greater capacity to carry moisture. In most cases, however the

maximum temperature of air used in drying should be 140 °F, the temperature at which seed damage begins to occur in crops like corn and soybeans. Other crops which are more delicate or oily may be limited to lower drying temperatures; contact your local Cooperative Extension Office for further information.

It is also critical to avoid over-drying, which wastes energy and can damage the grain, causing lower prices. Over-drying is likely to occur in deeply-filled bins having either very wet grain or highly varying moisture levels throughout the bin. A stirring device which constantly brings grain from the bottom of the bin to the top can help keep moisture levels consistent in bins. By reducing over-drying and heat damage, the energy use of a stirring device is generally more than offset by the energy it saves during drying. Crossflow dryers that mix or “swap sides” of the grain (sometimes called a double diamond configuration) can also improve uniformity and hence reduce overall drying and energy use.

A common way to save energy in grain drying is to use a bin and dryer flow path, called dryeration, in which, after grain leaves a crossflow dryer, the residual heat is used to release an additional 2 to 3% moisture into ambient-temperature air. In this process, grain drawn off the crossflow dryer is moved directly into a small holding bin, just large enough to hold as much grain as the dryer will process in a day. Until the bin is full, ventilation is not used, and the grain is allowed to cool slowly over 4 to 6 hours. As the grain sits, residual heat will vaporize moisture. After dryer operation has ceased and the bin is full, artificial ventilation is used for 10 to 12 hours to displace the now moisture-laden air from the bin. This process can save 10% or more in fuel use when compared to using a crossflow dryer alone. An additional benefit of dryeration is that, because it involves fairly slow cooling and because seeds are steeped in moisture-laden air, seed coat cracking is reduced. Dryeration also allows faster processing rates in the crossflow dryer, because less moisture needs to be removed in the dryer.

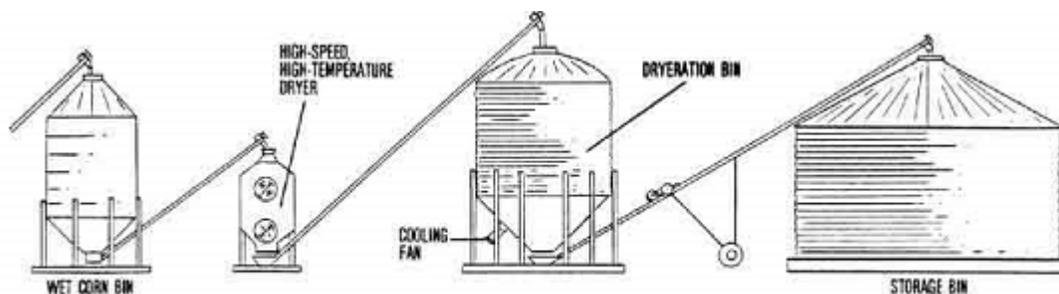


Figure 1. Schematic of dryeration (Source: Purdue University Extension Service)

An alternative to true dryeration is in-bin cooling, in which dryer output is put directly into ventilated bins. The difference between this process and true dryeration is that ventilation is used continuously, rather than only after grain has steeped. The main advantage to in-bin cooling over dryeration is that it decreases processing time because the grain is kept in the cooling bin for a much shorter time than it is in dryeration. The compromise is that only 1% or less moisture can be removed by this process. Note that this process requires significantly higher airflow than storage, so either dedicated cooling bins or upgraded storage bins are usually needed.

With proper equipment, summer-harvested small grains can typically be cooled and dried with unheated outdoor air. Ambient-temperature air, when drawn through less than about 15 ft of grain, can remove between 3 and 5% moisture over a month or so. This method is generally most effective in drying cereal grains, due to their lower moisture content at harvest. It is generally not suitable for corn or soybeans in wet falls during which the harvest moisture content is relatively high and the cooler ambient air can't drive sufficient moisture removal to reach

storage moisture levels. For best moisture removal, bin floors and plenums should be kept clean and free of dust. Annual cleaning is best but, at least, check for significant blockage periodically.

The efficiency of any dryer depends on proper loading and maintenance. For details on energy needed to dry grain in specific types of drying systems and conditions, see Hellevang (2013). It is essential to completely level the contents of any bin before aeration, cooling, or heated aeration. If a peak is present, an inordinate amount of air must be pumped before the grain in the peak dries, with the rest of the contents drying long before the peak. Also important in all drying operations is basic maintenance of equipment, such as properly tightened belts and clean motors. An inexpensive infrared thermometer should be used to check the case temperature of motors and compare that temperature to the nameplate temperature rise of the motor. After more than about 15 °F temperature rise above the nameplate level, efficiency drops significantly and the motor should be replaced or rewound.

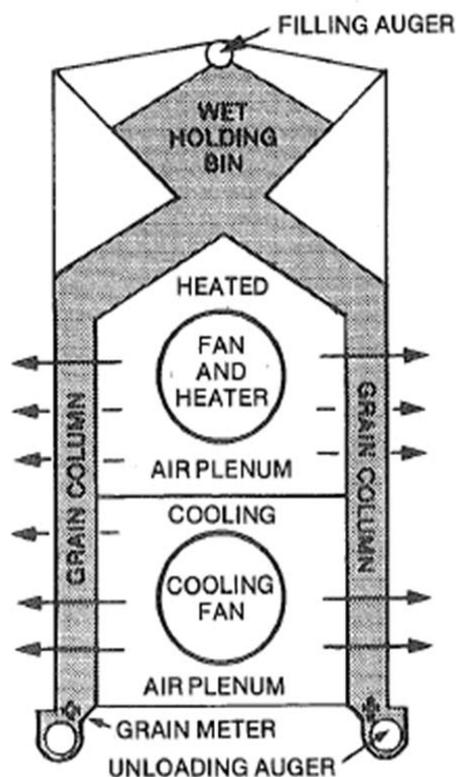


Figure 2. Bin Schematic for In-Storage Cooling and Drying (Credit: North Dakota State University.)

FUELS FOR DRYING

The source of heating energy plays a significant role in the drying process efficiency. Typically, grain drying process is fueled by LP gas. In terms of thermal efficiency, LP gas is on par with other sources of energy. However, LP gas prices have increased in recent years, meaning that other fuel sources may save money as well as energy. In areas where it is available, natural gas can be a less expensive and slightly more efficient fuel source than LP gas. Biogas from manure digesters can be used in grain drying. A serious limitation to this method is that biogas often cannot be compressed for storage at a net energy savings over off-farm natural gas, so it is only practical in larger livestock operations where sufficient volumes exist on site. It will also burn less efficiently than other fuel sources unless it is cleaned.

No. 2 or 1 fuel oil is sometimes used for grain drying, in applications where precise temperature control is not necessary. These fuels are comparable to LP gas in terms of thermal efficiency, and may be somewhat less expensive. The chief limitation in using fuel oil is that combustion temperatures are difficult to control, limiting their use to batch and crossflow dryers only. Oil may not be as efficient when used in the slower and more efficient drying processes such as dryeration and in-bin drying.

Grain drying may be a good use for biomass energy. In the Midwest, in the past, a common method of heating dryers for seed corn was the direct combustion of corncobs, which can provide about one-third the heating value on a per-pound basis as LP gas provides. Corncobs, wood residues, and other biomass can be burned in a variety of commercial or homemade boilers where modifications can be made by either changing the chain and grate to burn larger pieces of material, or by chopping the biomass. This approach is most efficient in a forced air unit close-coupled to drying equipment. Maintaining constant air temperature is a significant challenge with biomass energy, even more so than it is with oil heat (Brunner, 2011; Zych, 2008).

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