Farmer Question: How Can I Reduce Energy Costs When Drying Grain?

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With prices for most energy sources up dramatically in the past two years, grain producers are asking how to reduce the cost of drying grain on the farm. Like most management decisions, the grain drying method chosen usually is a trade-off between time and money. The least cost, but slowest, drying method is natural (unheated) air in-bin drying. Next lowest in cost will be heated air in-bin drying. High temperature, high capacity column or continuous flow dryers will dry grain the quickest but have the highest energy costs. This article will discuss these drying systems and tell about some management techniques to reduce costs and result in higher grain quality.

All mechanical grain drying systems use a fan to push air through the grain mass to remove moisture. In deep bed, in-bin drying systems, a drying zone is established and moves through the grain in the direction of airflow. One can monitor the movement of the drying zone through the bin by sampling with a grain probe. Grain above the drying zone remains unchanged or may be slightly wetted by the saturated air leaving the drying zone. Grain below the drying zone will eventually come into a state of equilibrium with the incoming air.

IN-BIN DRYING

Natural Air Drying

As stated, natural air drying uses unheated air to dry grain. The time required to push a drying zone through a bin of grain with natural air can be several days to several weeks, depending on the initial and final moisture content of the grain, airflow (cubic feet per minute per bushel, cfm/bu) and the air properties (temperature and relative humidity).

Research has found stirring grain being dried with natural air actually prolongs the time required to dry grain because it disrupts the drying zone, resulting in exhaust air leaving the grain mass less saturated.

If a stirring device is installed in a bin being dried by natural (unheated) air, the stirring device should be run during the filling period to reduce the pack factor from the filling operation, redistribute fines and to level the grain. Stirring should then be discontinued to allow a drying zone to develop in the grain. Since the bottom of the bin will be somewhat over-dried, a final stirring just before the drying zone is pushed completely through the bin will help to equalize the moisture content of the grain.

Heated Air Drying

One can significantly reduce drying time by adding heat to the air used for drying grain. Heating air does not reduce the quantity of water vapor in the air, but it does increase the amount of water vapor the air can hold (it lowers the relative humidity). Therefore, heated air has the potential to pick up more moisture per unit volume passing through the grain than unheated (natural) air.

When adding supplemental heat, the relationship between temperature rise and relative humidity is not linear. A rough rule of thumb is the relative humidity drops by one-half for each 20° F rise in temperature. For example, natural air at 60° F and 50% relative humidity will have a relative humidity of 25% if heated to 80° F. Adding another 20° F to raise the temperature to 100° F cuts the relative humidity by about half again and results in a drop to 13.5%. The third 20° F rise to 120° F lowers the relative humidity by about half again to 7.6%. The notable point is the second 20° F increment of added heat results in half as much reduction in relative humidity (half of half) and the third increment results in only one-eighth as much reduction (half of half of half). To minimize energy cost for drying grain, keep the temperature rise to a moderate level. The biggest savings in drying time versus energy input for in-bin drying systems is achieved with the first 20° F to 40° F rise in air temperature.

Table 1 presents the results of a computer simulation comparing the electrical and propane energy costs for batch in-bin drying with natural air at 60° F and 50% relative humidity compared to heating the air to 80° F or 95° F. Note the drying time versus total energy cost comparison in the last column. Boosting temperature by 20° F to 80° F resulted in a drying time only 42% as long as natural air but the energy cost increased by 39%. Boosting temperature by 35° F to 95° F resulted in a drying time only 31% as long as natural air drying but resulted in a 74% increase in energy cost.

Management of stirring devices is different for heated air drying than natural air drying, especially for high temperature drying (over 40° F temperature rise). The relative humidity of the incoming air is so low with heated air drying, the grain on the bottom of the bin is over-dried by several percentage points by the time the drying front is pushed through the full depth of the grain. Stirring devices, if installed, should be run continuously with high-temperature heated drying systems to help equalize the moisture content of the grain mass and avoid over-drying at the bottom of the bin.

Layer Drying

If a producer has several bins equipped with drying fans and is able to switch over from filling one bin to another in a reasonably short time, filling and drying several bins in layers could reduce drying time and energy consumption by 20–35% as compared to completely filling each bin in turn before beginning to fill the others.

Aeration fans operate on a static pressure (measured in inches of water) versus air output (cfm) curve. Static pressure increases with greater depths of grain in the bin and with higher airflow (cfm) per bushel. The higher the static pressure the fan must overcome, the fewer cfm the fan can push through the grain.

Since drying time is a function of the airflow per bushel (cfm/bu), both factors work in our favor when drying in layers as opposed to starting with a full bin — whether using natural or heated air for in-bin drying.

For example, consider the advantages of filling and drying a bin in four layers as opposed to the usual practice of filling the entire bin from the start. The first layer will have far greater total airflow moving through only one-fourth as many bushels. This cuts the drying time substantially. The reduced drying time advantage continues as the second and third layers are added, with diminishing effect as the grain depth increases. Layer drying results in much shorter total drying time for the bin of grain and a big reduction in energy consumption.

Stirring devices should not be used in layer drying systems until the final layer of grain is added. Long distances to the grain mass and unsupported shafts can cause unpredictable behavior that could damage the stirring device or the bin sidewalls. Once the final layer has been added, consider blending the wet and dry grain with the stirring device then use unheated air to help the migration of moisture from the moist kernels to those that are likely over-dry due to the heated air drying.

HIGH SPEED–HIGH CAPACITY DRYERS

High speed batch or continuous flow dryers have the highest bushel capacity per hour of any of the systems mentioned in this article. Temperature, grain bed depth and airflow rates are vastly different in high speed, high-capacity dryers compared to deep-bed, in-bin drying systems. Air temperatures of 120 to 140°F are typical in high capacity dryers. Column widths of grain being dried are measured in inches (10 to 20 inches) in batch or continuous flow dryers as opposed to feet (4 to 20 feet) for in-bin drying systems. Airflow rates of 50 to 100 cfm/bu are common in high speed dryers as opposed to 1.25 to 2.5 cfm/bu for deep bed in-bin systems.

There are two limiting factors that affect the efficiency of high capacity systems. The first limiting factor is the rate moisture can migrate from the interior of the kernels to the surface where it can evaporate into the air stream. The second factor is the short contact time the air stream has with the grain. High volumes of very hot and dry air moving through shallow beds of grain result in the air leaving the grain mass much less saturated compared to deep-bed, in-bin drying systems. This is reflected in higher energy cost per point of moisture removed per bushel as compared to in-bin systems. Some high capacity dryers recover some energy by channeling the air used to cool the grain back into the drying chamber air stream or by re-circulating a high percentage of the previously heated air back through the grain mass.

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Table 1. Comparison of total energy consumption and cost vs. drying time for three drying scenarios.

Air temperature	kWh ➔ cost $	Gal. LPG ➔ $LPG	Drying time, hr	Total cost for energy	% Time–% cost (vs. natural air drying)
Natural air 60° F and 50% relative humidity	3,073 ➔ $246	0 ➔ $0.00	94.6	$246	100%–100%
Heated to 80° F	1,279 ➔ $102	191.2 ➔ $239	39.4	$341	42%–139%
Heated to 95° F	952 ➔ $76	280.4 ➔ $351	29.3	$427	31%–174%

Assumptions: Fan = 25hp centrifugal. Grain = Corn, Initial = 20.5% - Final = 15.5% moisture. Bin diameter = 30 feet, Grain depth = 8 feet, Bushels per batch = 4,500 bushels. Electrical: 32.5 kWh per hour for fan operation at $0.08/kWh = $2.60 per hour. Propane: $1.25/gallon, 90,000 BTU per gallon.

Avoid Pasture Damage During Fall Grazing

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Many of us have had more moisture to support pasture growth this year than for several years. Don't take too much advantage of the extra growth, however. After years of drought and low production, this extra growth is more than welcome. But as we approach the end of the growing season, don't get too greedy and try to completely graze off every green blade.

Do you have pastures dominated by cool-season grasses? Like bromegrass, bluegrass or wheatgrasses or maybe needlegrasses? Recent rain and cooler temperatures could give these grasses some good growth in September. It's tempting to keep cattle on these nice green pastures as long as possible to use all this growth. But if these same pastures suffered much drought stress the past couple years, their recovery will be hindered if you fail to allow them ample opportunity to rejuvenate their root systems prior to winter.

Grazing pastures short just before winter begins limits the plant's ability to develop the roots and tiller buds needed to fulfill their growth potential next spring. Those extra mouthfuls of grass harvested now could cost you many more mouthfuls next spring.

To help pastures recover from past stress and set the stage for abundant growth next spring, be sure to keep several inches of green leaves on your grasses the rest of this growing season. These green leaves will convert fall sunlight into tiller buds, root growth and root nutrient reserves. Next spring, these plants will be ready to grow rapidly and yield much more than if grazed short this fall.

Don't be greedy. Protecting some of your grass from grazing this fall could pay big dividends next spring.