

# 9 - On Farm Storage and Drying

Dennis R. Gardisser



A good deal of Arkansas grain sorghum will be dried and stored on the farm each year. Grain sorghum has the highest quality it will ever have at harvest. Grain has a limited storage life. The way that grain sorghum is handled during the drying and storage process will determine how much of this quality is retained. Proper management practices may also prolong the storage life of grain.

Grain sorghum should be quickly dried down to a moisture level of about 12 percent for storage – particularly if it is going to be stored for several months. The reduction of grain moisture is done by passing relatively large quantities of dry air over the grain sorghum after it is placed in the bin. The quality of this air determines the final moisture content of the grain sorghum kernel. This “air quality” is typically referred to as the equilibrium moisture content (EMC). If the air has an EMC of 12 percent and is moved over the grain long enough, then the grain moisture will eventually reach 12 percent.

A given volume of air has the capability of holding a given amount of moisture. The amount of

moisture that air can hold will depend on the quality. One way to increase drying potential or cause the grain to reach equilibrium with the air sooner is to pass larger amounts of air over the grain. Doubling the air flow will typically cut the drying time in about half.

Pass or continuous flow dryers are often utilized to speed up the drying process. These high flow driers pass very large amounts of high temperature air over the grain sorghum. Three to six moisture points may be taken from the grain in a single pass. This helps to prepare grain for shipment if the desire is to market the grain quickly. Quickly drying the grain down to values of 16 percent or less will lessen potential spread of toxins if that is a concern. In-bin drying is more gradual and may cause less stress and potential damage on the kernels.

As grain bins are filled and the grain depth increases, it becomes more difficult to pass air up through the grain. As the grain depth increases, there is also less air available for each bushel of grain in the bin. High volumes of air are needed to carry the moisture away in a timely fashion when the grain is at high moisture levels. Most on-farm bins have a limited amount of available air capacity.





These criteria dictate that bins should not initially be filled too full if the grain is at a high moisture content. Once grain moistures reach 15 percent or less throughout the bin, the bin filling process may be completed. Graph 9-1 illustrates the dramatic increase in fan horsepower/capacity needed to push air through varying depths of grain. Requirements can quickly overwhelm available power as the grain depth and air requirements (CFM – cubic feet per minute) increase.

Several rules of thumb have been developed for sizing fans for drying systems<sup>1</sup>: (1) doubling the grain depth at the same cfm/bushel air flow rate requires 10 times more horsepower and (2) doubling the cfm/bushel air flow rate on the same depth of grain requires 5 times more horsepower.

Air flow rates for drying vary from 0.5 cfm/bushel to more than 50 cfm/bushel for commercial or batch dryers. Most on-the-farm air flow rates for drying vary from 0.5 to 6 cfm/bushel dependent on the initial moisture content of the grain and the amount of heat added to the drying air. Recommended minimum air flow rates for different moisture contents are as follows.

% moisture	cfm/bushel
11 to 13	0.5
13 to 15	1
15 to 18	2
18 to 20	3
20 to 22	4
>22	6

When air flow rates are less than 1 cfm/bushel, add little or no heat. A rough guide for temperature increases through the heaters at various air flow rates is as follows.

- For an air flow rate of 1 to 2 cfm, limit the temperature rise to 6°F.
- For an air flow rate of 2 to 3 cfm, limit the temperature rise to 12°F.
- For air flow rates above 3 cfm, a 20°F temperature rise is permissible. A temperature rise above 20°F is satisfactory for some feed grains when drying depths are less than 4 feet or stirring depths are used.
- Batch and/or pass dryers typically use much higher temperatures, but also have much higher air flow rates. Grain kernels may protect themselves somewhat as long as they are giving up water and there is evaporative cooling in or near the kernel.

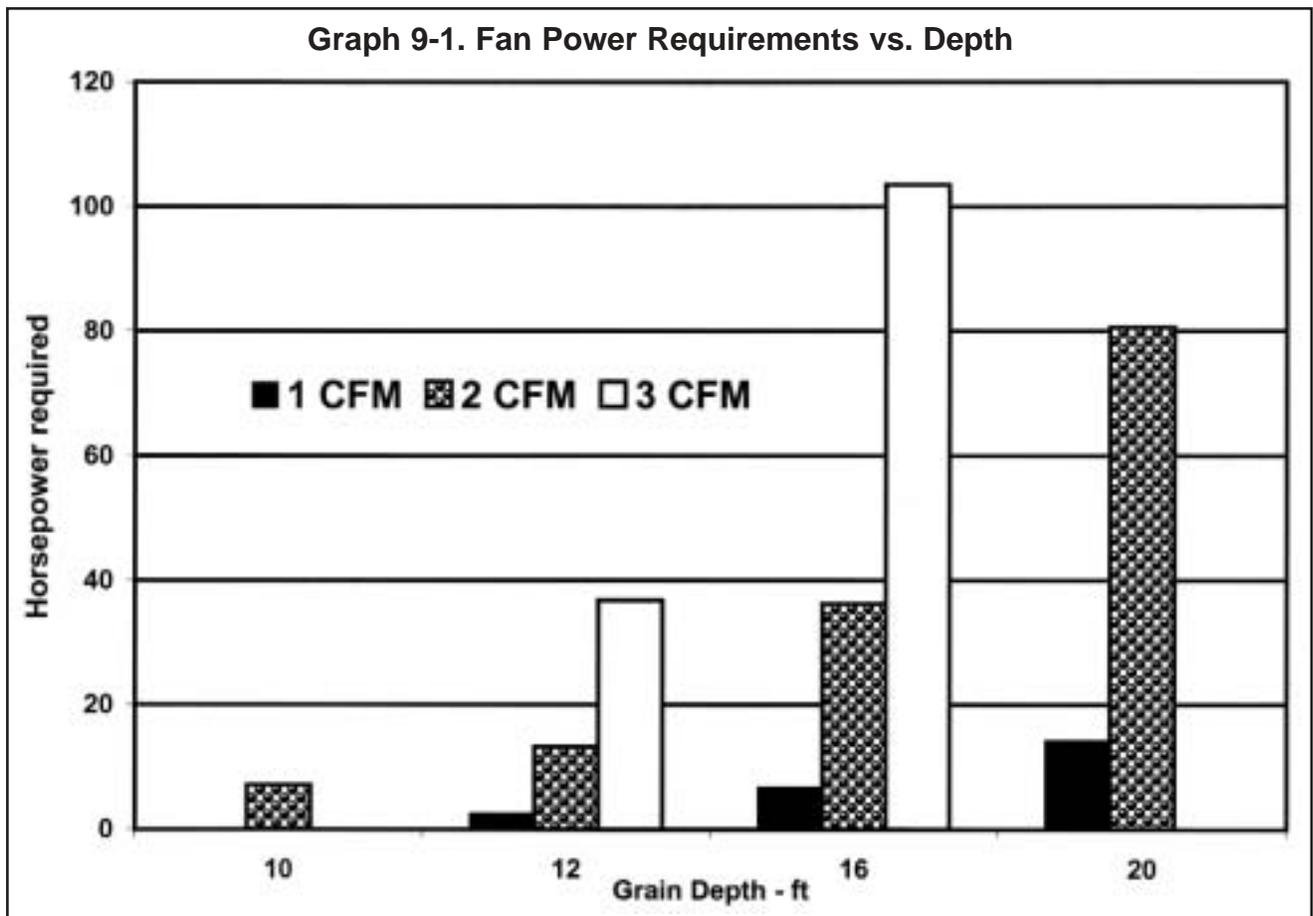
In most on-the-farm storage, the grain is subjected to modest temperatures for long periods of time. There must always be sufficient air flow to cool the upper portions of the bin to eliminate the possibility of mold development in that area. The top layers are the last segment of the bin to reach a safe moisture level.

Grain may be dried without adding any heat if the EMC is low enough. Careful monitoring of the EMC and managing drying times to optimize low values will provide the most economical drying. Many times Mother Nature simply will not provide dry enough air, particularly at night, and the addition of heat is needed to condition the air to the correct EMC.

## Fan Types

**Vane-axial fans** supply more cfm per horsepower at static pressures below 4.0 to 4.5 inches of water, low grain depths, than centrifugal fans. For this reason, these fans are generally better adapted to shallow-depth bin drying systems, such as batch-in-bin and continuous-in-bin

<sup>1</sup>AE-106, *Fan Sizing and Application for Bin Drying and Cooling of Grain*, Purdue University CES.



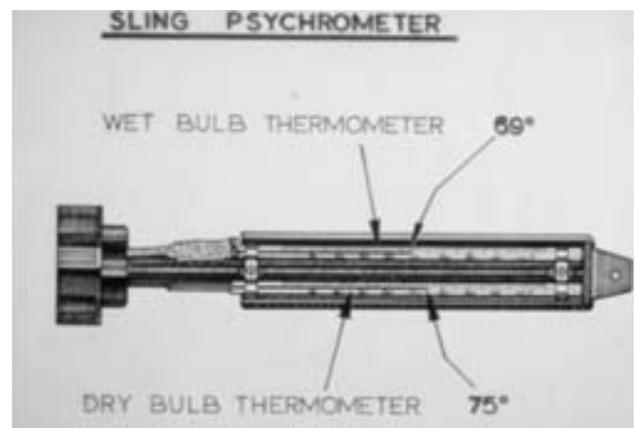
systems, and to deep bin drying up to 20-foot depths requiring 1 cfm/bushel air flow or less. They are generally lower in initial cost, but operate at a higher noise level than centrifugal. These fans are generally not acceptable for use with bins that will also handle rice because of the high static pressures that are expected – typically, air is more difficult to move up through a column of rice.

**Centrifugal fans** supply more cfm per horsepower at static pressures above 4.0 to 4.5 inches of water than vane-axial fans. These are especially advantageous when the application requires relatively high air volumes through deep grain levels (12 to 20 feet), and where low noise is important. Larger diameter centrifugal fans typically move more air per horsepower.

All fans are susceptible to a reduction in the amount of air that can be moved as the static pressure increases. Air flow will be less when fan blades are coated with lubricants, dust and other foreign materials. Keep all fan blades clean for maximum performance.

Care should be taken not to mix dry grain (moisture content less than 15 percent) with moist grain (moisture content greater than 18 percent). Re-wetting may also occur if damp air is pumped through the grain.

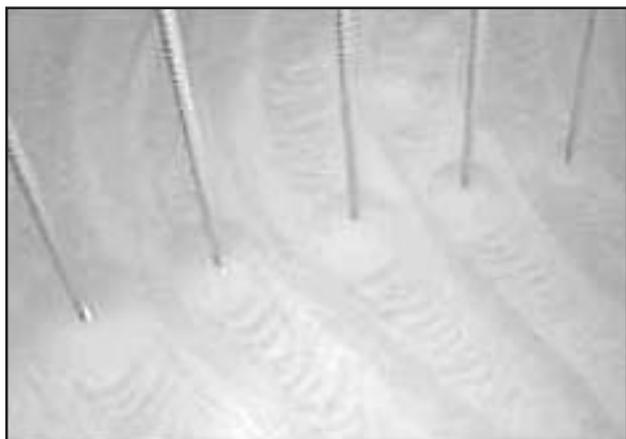
The EMC may be determined by measuring air temperature and relative humidity. A sling psychrometer is one the best tools for measuring relative humidity, and is relatively inexpensive. A sling psychrometer works by measuring the air



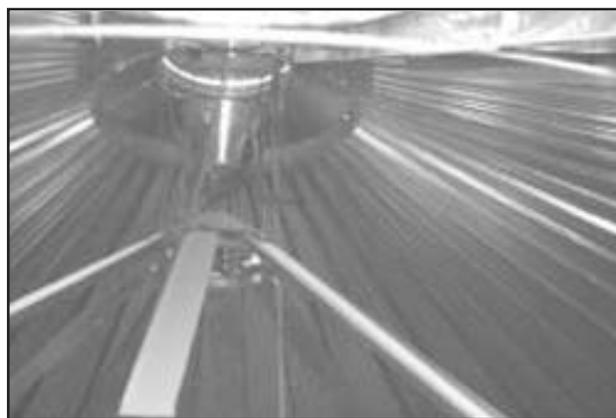
temperature with a wet and dry bulb thermometer, and then using a table to determine relative humidity.<sup>2</sup>

One should strive to maintain a steady EMC that is very close to the target storage moisture content. There are typically numerous days during and shortly after the harvest season when the EMC is at or below the desired level without adding any heat. At night or during damp weather conditions it may be necessary to add some heat to condition the air to a desirable EMC – or to maintain the same level available during the daylight hours.

If heat is not available, it may be better to turn the fans off at night instead of pumping in moist air. Moist air that is pumped in at night has to be removed later. This increases drying cost and may result in significant quality reductions. Fans should be turned off almost any time the EMC of the air is greater than that of the grain. The exception might be for very damp grain sorghum – to avoid heat buildup.

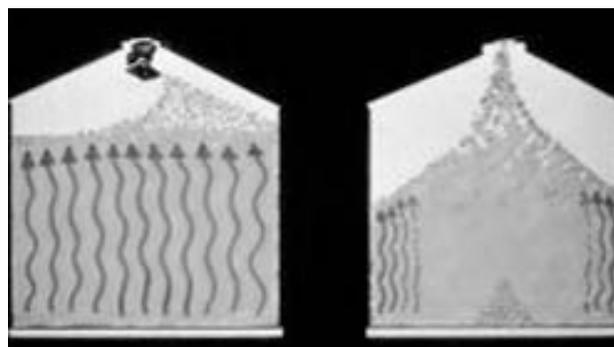


Stir-alls help to mix the upper and lower portions of grain in the bin. This speeds up the drying process and loosens the grain so that additional air may be moved up through the grain. Stir-alls also help to keep the grain level in the bin. Stir-alls should not be turned on unless the bottom end of the auger is about 1 foot deep in grain. They can run almost continuously after that point, when the drying fans are running. There is a concern among many producers that the stir-alls may grind away at the grain sorghum if left on, but there is no



research evidence to support this. There will be a small amount of flour-like substance formed around the auger top, but the small particles were most likely already there and are just being gathered in one place with the auger action.

Grain should not be allowed to cone or pile to one side as the bin is being filled. If coning or sloping occurs, the large particles will migrate to the outside and the flour-like small particles and trash will remain at the center of the cone. This results in a very non-uniform amount of air being passed through each portion of the grain. Most of the air will pass up the outside of the bin through the larger and cleaner grain. A level height should be maintained throughout the filling process. Grain sorghum may include a lot of fines and small particles that will drastically reduce air flow up through the center of the bin if coning is allowed. Once the separation occurs, it is hard to remedy – even if the bin is later shoveled level. Do not fill a bin to a peak or until the grain touches the roof. This will interfere with uniform air flow and prevent moisture movement out of the grain surface. Level fill works best at any level!



<sup>2</sup>Sling Psychrometer sources: [www.seedburo.com](http://www.seedburo.com) and [www.forrestrysuppliers.com](http://www.forrestrysuppliers.com).

## Drying Costs

$$\text{Fuel Cost (\$/bu)} = \frac{(\text{BTU/lb water} \times \text{lb water removed/bu} \times \text{cost of fuel per unit} \times 100)}{(\text{BTU/unit of fuel} \times \text{burning efficiency (\%)})}$$

The number of BTUs to extract 1 pound of water will vary from 1,100 to 1,400 and is a function of how easily moisture is given up by the kernel. As the kernel begins to dry, it takes more energy to get the last bit of moisture out. A good estimate is to use an average number of 1,200 BTU/pound of water. BTUs/unit of fuel are LP Gas – 92,000 BTU/gal, natural gas – 1,000 BTU/ft<sup>3</sup>, and electricity – 3,413 BTU/kWh. Burning efficiencies are 80 percent for LP and natural gas and 100 percent for electricity.

## Long-Term Storage Management

- Cool grain off as soon as possible in the fall. Target temperatures should be initially around 60°F.
- Continue to aerate and uniformly cool grain down to 30° to 40°F if possible. This will help avoid internal moisture migration and insect activity.
- Monitor grain and aerate monthly to maintain uniform temperature and moisture levels throughout. Aerate more often if moisture or temperatures increase.
- Keep grain cool as long as possible into the early spring.
- Do not aerate in early summer unless problems develop.
- Cover fans and openings when not in use to help avoid air, moisture and potential insect movement.
- Monitor carefully and fumigate if needed. The grain surface should be inspected at least every week throughout the storage period. Walk over the grain and poke around with your arm or a rod, smelling, feeling and looking for

indications of trouble. Evidence of hot spots, warming, insect infestations or other problems that start in the grain mass soon migrate to the surface. Be particularly sensitive to damp, warm or musty areas.

- Keep the area around the bins as clean as possible to avoid rodent infestations.
- Seal all areas around the bottom of the bins and keep transfer equipment sealed to keep rodents from migrating into the system.

## Safety

- Always think safety around grain bins.
- Wear appropriate masks when working around dusts – particularly from moldy or spoiled grain. Exposure to and inhaling mold can cause severe allergic reactions.
- Never enter a bin when grain is being unloaded.
- Beware of crusted grain.
- It is best to work in pairs – one inside with a safety harness and one outside to assist if needed.
- Grain suffocation accidents happen all too often – think before you act or enter a bin!

These drying concepts and other details are discussed in MP213, *Grain Drying*, available at your local county Extension office. Corn drying is not overly complicated, but does require a good manager to maintain the highest corn quality.

## Additional Resources

Internet resources at <http://www.agcom.purdue.edu/AgCom/Pubs/AE/>

AE-90, *Managing Grain for Year Round Storage*

AE-91, *Temporary Corn Storage in Outdoor Piles*

AE-93, *Adapting Silage Silos for Dry Grain Storage*

AE-106, *Fan Sizing and Application for Bin  
Drying/Cooling of Grain*

AE-107, *Dryeration and Bin Cooling for Grain*

AE-108, *Solar Heat for Grain Drying*

AED-20, *Managing Dry Grain in Storage*

Mid West Plan Service-Publications, 122 Davidson  
Hall, Iowa State University, Ames, IA 50011-3080

MWPS-13, *Planning Grain-Feed Handling*  
(\$2.50)

MWPS-22, *Low Temperature and Solar Grain  
Drying* (\$3.00)