Chapter

16

Fundamentals of On-Farm Rice Drying and Storage

Sammy Sadaka and Jarrod Hardke

Arkansas rice producers are increasingly adopting the use of on-farm drying and storage facilities. Quality is the major factor affecting the market value of rice, and proper management of rice dried and stored on-farm is essential to maintaining high quality rice. Immediately following harvest, rice quality is typically at its peak. The final quality of rice ready to market is sensitive to all post-harvest processes, such as drying, handling, storage and milling. On-farm rice drying and storage has the potential to increase harvest efficiency, reduce harvesting delays and provide more control over grain quality, all of which contribute to overall market/delivery time flexibility.

Management Key

Follow the "50-50 Rule" and do not attempt to dry grain when the temperature is below 50 degrees or when the humidity is above 50 percent.

Tips for Rice Drying

The goal of rice drying is to reduce grain moisture content to meet the recommended levels for safe, long-term storage. When placed in storage, rice should be dried quickly to a moisture level of about 12 percent to minimize any quality deterioration. Rice drying can be accomplished in bins by blowing large volumes of dry air through the grain (Photo 16-1).

The flow rate and the quality of this air determine the drying duration and the final moisture content of the rice kernels. Air quality typically refers to the equilibrium moisture content (EMC) achievable under the conditions of the air. (Table 16-1). If the EMC of air is 12 percent, then rice moisture will eventually reach 12 percent. It is important to know that a given volume of air has the capability of holding a given amount of moisture. The amount of moisture a volume of air can hold depends on its quality.

Photo 16-1. Grain drying facility.

Therefore, it is possible to increase the drying rate, or force the grains to reach equilibrium with air sooner, by passing larger amounts of air over the grain. High volumes of air are needed to carry the moisture away

Table 16-1. **Long-grain rice equilibrium moisture content.**

		Relative Humidity (%)													
		25	30	35	40	45	50	55	60	65	70	75	80	85	
Temperature	35	9.2	10.1	10.9	11.7	12.5	13.3	14.1	14.9	15.7	16.6	17.6	18.6	19.8	21.3
	40	9.0	9.9	10.7	11.5	12.3	13.0	13.8	14.6	15.4	16.3	17.2	18.2	19.4	20.9
	45	8.8	9.7	10.5	11.2	12.0	12.8	13.5	14.3	15.1	15.9	16.9	17.9	19.0	20.5
	50	8.6	9.5	10.3	11.0	11.8	12.5	13.3	14.0	14.8	15.7	16.5	17.5	18.7	20.1
	55	8.5	9.3	10.1	10.8	11.5	12.3	13.0	13.8	14.5	15.4	16.3	17.2	18.4	19.8
	60	8.3	9.1	9.9	10.6	11.3	12.1	12.8	13.5	14.3	15.1	16.0	16.9	18.1	19.5
	65	8.2	8.9	9.7	10.4	11.1	11.9	12.6	13.3	14.1	14.9	15.7	16.7	17.8	19.2
	70	8.0	8.8	9.5	10.3	11.0	11.7	12.4	13.1	13.8	14.6	15.5	16.4	17.5	18.9
	75	7.9	8.7	9.4	10.1	10.8	11.5	12.2	12.9	13.6	14.4	15.2	16.2	17.2	18.6
	80	7.8	8.5	9.2	9.9	10.6	1.3	12.0	12.7	13.4	14.2	15.0	15.9	17.0	18.3
	85	7.6	8.4	9.1	9.8	10.5	11.1	11.8	12.5	13.2	14.0	14.8	15.7	16.8	18.1
	90	7.5	8.3	9.0	9.6	10.3	11.0	11.6	12.3	13.0	13.8	14.6	15.5	16.5	17.8
	95	7.4	8.1	8.8	9.5	10.2	10.8	11.5	12.2	12.9	13.6	14.4	15.3	16.3	17.6
	100	7.3	8.0	8.7	9.4	10.0	10.7	11.3	12.0	12.7	13.4	14.2	15.1	16.1	17.4

in a timely fashion when rice is at high moisture levels. Doubling the airflow will typically cut the drying time to about half. It is also possible to add heat to condition the air to a desirable EMC – or to maintain the same level available during the daylight hours. If the EMC of air is greater than 12 percent, then it will not be possible to reduce rice moisture to 12 percent. In this situation, the air can be heated to reduce the EMC to 12 percent. While heating the air typically reduces its EMC and increases its moisture-holding capacity, it is important to consider the added cost to the drying process. Airflow rates for drying vary from a low of 1 cubic foot per minute (CFM) per hundredweight (cwt) to a high of 100 or more CFM per cwt. The recommended minimum airflow rates for different moisture contents levels are shown in Table 16-2.

Management Key

One way to reduce drying time is to increase airflow, but this may not be the most energy efficient manner of drying.

Air may be delivered to the drying bin by a centrifugal fan or an axial flow fan. Manufacturers provide several models of these fans to meet the needs of field applications. The two critical characteristics of fans are flow rate (CFM) and static pressure expressed in inches of water.

Table 16-2. **Recommended minimum airflow rates for different moisture content levels.**

Moisture Content	Airflow Rate
%	CFM†
13-15	1-2
15-18	4
18-20	6
20-22	8
> 22	12

† Cubic foot per minute per cwt.

The axial fan (Photo 16-2) utilizes a propeller wheel mounted directly to the motor shaft; thus, it develops a very high tip speed and is often noisy. Axial fans are cheaper and are most often used where high airflow rates, at low static pressures, are needed.

Centrifugal fans (Photo 16-3) provide a relatively constant air volume over a wide range of static pressures. Centrifugal fans are more expensive than axial fans and can be purchased as a direct-driven or a belt-driven unit. Belt-driven units are more expensive but have a greater life expectancy. Centrifugal fans are highly recommended where high static pressures and less noise are needed.

Practically, most on-farm bins have limited available air capacity. As grain bins are filled and the grain depth increases, it becomes more difficult to move air up through the grain. Additionally, less air will be

Photo 16-2. Axial fan.

Photo 16-3. Centrifugal fan.

available for each bushel of grain in the bin as it becomes full. This is why, initially, bins should not be completely filled with high moisture content grain. Once grain moisture reaches 15 percent or less throughout the bin, the bin filling process may be completed. However, care should be taken not to mix dry grain (less than 15 percent moisture) with moist grain (greater than 18 percent moisture). The reason is that any rewetting after the rice kernel is dried to a level below 15 percent may cause excessive fissuring

Management Key

Dry high moisture rice in shallow depths until 15 percent moisture or less, then deeper depths can be dried.

and reductions in head rice yield (HRY). Rewetting may also occur if moist air is pumped through the grain.

The EMC can be determined by measuring the air temperature and relative humidity. Thermometers, or temperature sensors, are typically used to determine the temperature, while the relative humidity is usually determined by using a sling psychrometer. Sling psychrometers (Figure 16-1) are relatively inexpensive, and they work by first measuring the air temperature with a wet and dry bulb thermometer and then determine relative humidity using a table. One should strive to maintain a steady EMC that is very close to the storage moisture content. There are typically numerous days during the harvest season when the EMC is at, or below, the desired level without adding any heat.

Figure 16-1. Sling psychrometer.

As mentioned earlier, it may be necessary to add some heat to condition the air to a desirable EMC during night or damp weather conditions. If heat is not available, it may be better to turn the fans off at night instead of pumping in moist air. Pumping in air at night may actually add moisture to the bin that will have to be removed later. This increases drying costs and may result in significant HRY 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 rice – to avoid heat buildup.

Management Key

Exercise extreme caution when drying air temperature exceeds 100°F.

As the bin is being filled, grain should not be allowed to cone. If coning occurs, the large particles will migrate to the outside and small particles (flour and trash) will remain at the center of the cone

(Figure 16-2). This results in a non-uniform distribution of voids among the grains, which leads to uneven air flow distribution through 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. Once the separation occurs, it is hard to remedy later – even if the bin is later shoveled level.

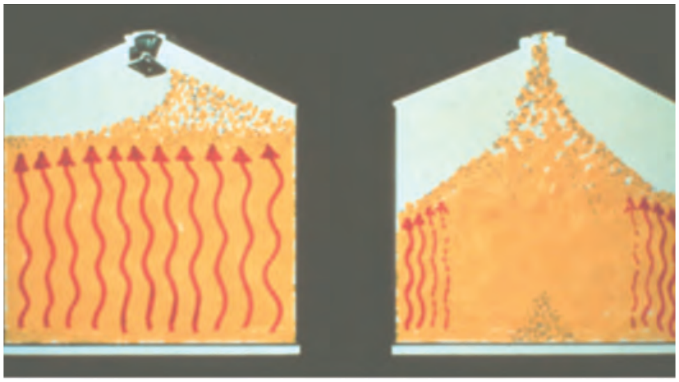

Figure 16-2. Grain bin filling and coning.

A stirring method is needed in grain drying as well. Stirring facilitates the drying process by lifting grain from the bottom to the top. It also facilitates aeration and removes hot spots; therefore, it helps maintain grain in store and speeds the drying process. Stirring also makes the grain flow extremely well which improves grain handling. This loosens the grain so that additional air may be moved up through the grain. On the other hand, there is a concern among some producers that the stirring may grind away the rice if left on. There is no research evidence to support this concern. There will usually be a small amount of flour-like substance formed around the auger's top.

Tips for Rice Storage

Once rice has been successfully dried to about 12.5 percent moisture throughout the storage container, the bin can be filled and the surface leveled. After this has been accomplished, aeration is needed to limit the amount of heat generated by bulk stored rice. Aeration with ambient (outside) air may be needed for the next few weeks, but only when humidity is below 60 percent and the air temperature is 50 to 60°F. Do not operate fans when air temperatures are below 32°F.

Bulk rice stored in bins should be monitored at least once a week for variation in temperature or moisture. Moisture migration can occur in bins with improper temperature control and can result in deterioration or spoilage of kernels. Periodic aeration may be necessary to counter extreme temperature changes during storage.

Additional information on rice drying and storage can be found here: https://www.uaex.edu/farm-ranch/crops-commercial-horticulture/Grain_drying_and_storage/rice_drying_and_storage.aspx.