Chapter 8

Rice Drying on the Farm

Dennis Gardisser and Johnny Saichuk

Drying and storing rice on the farm can be an excellent marketing strategy. The way that rice is handled during the drying and storage process will determine its quality at the point of sale, thereby influencing its value.

Rice should be quickly dried down to a moisture level of about 12 percent for storage, especially 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 rice after it is place in the bin. The quality and quantity of this air determines the final moisture content of the rice kernel.

Air quality is typically referred to as the equilibrium moisture content (EMC). It is the combination of temperature and relative humidity at which rice will not gain or lose moisture from the air. If the air has an EMC of 12 percent, the grain moisture will eventually reach 12 percent if air of that quality is moved over the grain long enough.

The EMC may be determined by measuring air temperature and relative humidity. Relative humidity is determined by measuring wet bulb and dry bulb temperatures and comparing these values with a table. Relative humidity is a measure of how much moisture is in the air at a given temperature in comparison with how much it could hold at that same temperature. At 100 percent relative humidity, the air is holding all of the moisture it is capable of holding at that temperature. The actual amount of moisture capable of being held varies with air temperature. Hot air holds more water than cold air. Wet bulb and dry bulb temperatures are measured by using a device called a sling psychrometer. This device has two identical thermometers, but the bulb of one is covered with a cloth sack that is moistened when it is used. The thermometers are mounted on a board or similar structure that permits them to be slung through the air. The wet bulb temperature will be lower than the dry bulb as a result of evaporative cooling.

In drying rice, maintaining a steady EMC as close to the target storage moisture (12 or 13 percent) content is important. Usually, there are many 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 head rice yield reduction. 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.

A given volume of air has the capability of holding a given amount of moisture. That amount 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 air flow typically cuts the drying time in about one-half. 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. Recommended minimum airflow rates for different moisture contents are:

13 to 15% moisture	1 to 2 CFM per cwt
15 to 18% moisture	4 CFM per cwt
18 to 20% moisture	6 CFM per cwt
20 to 22% moisture	8 CFM per cwt
22 % moisture and above	12 CFM per cwt

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, less air is available for each bushel of grain in the bin. High volumes of air are needed to carry the moisture away in

Fig. 8-1. Axial flow fan.

a timely fashion when the grain is at high moisture levels. Most on-farm bins have a limited amount of available air capacity.

The grain drying industry offers basically two types of drying fans, the centrifugal and axial flow fans. From these two types, manufacturers provide a number of variations 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.

The axial fan utilizes a propeller wheel mounted directly to the motor shaft; thus, it develops a very high tip speed and is often noisy (Fig. 8-1). Some axial fans incorporate air straightening vanes to increase efficiency and increase static pressure. The normal upper limit of static pressure of an axial fan is about 5 inches of water. Axial fans are cheaper and are most often used where high airflow rates at low static pressures are needed.

Centrifugal fans provide a relatively constant air volume over a wide range of static pressures with a practical limit of 9 to 10 inches of water (Fig. 8-2). Higher static pressures can be obtained with special design; however, the 9 to 10 inches of water pressure will meet most on-farm drying system needs. 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 are needed (Fig. 8-3).

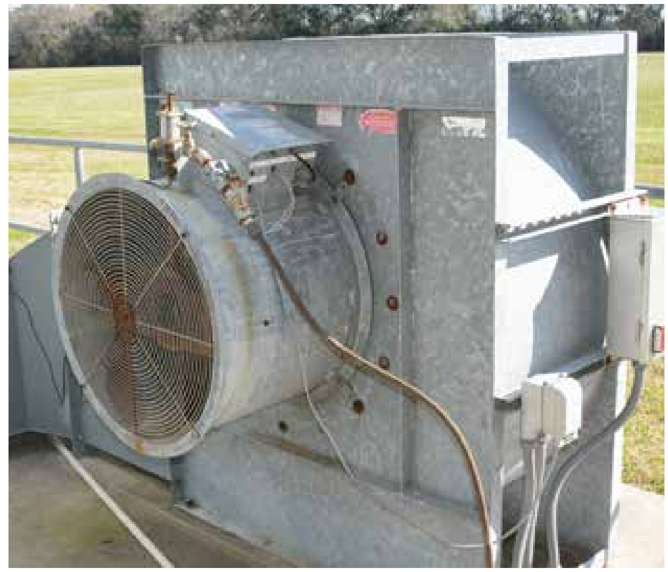

Fig 8-2. Centrifugal fan.

Fig 8-3. Blades of centrifugal fan.

These criteria dictate that bins should not initially be filled too full if the grain is at high moisture content. Once grain moisture reaches 15 percent or less throughout the bin, the bin filling process may be completed.

Dry grain (moisture content less than 15 percent) should not be mixed with moist grain (moisture content greater than 18 percent). Once a rice kernel is dried to a level below 15 percent, any rewetting may cause excessive fissuring and reduction in head rice yield. This also may occur if damp air is pumped through already-dry grain.

Stirring devices 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

Fig. 8-4. Temperature is critical in drying rice.

and similar devices 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. Many producers are concerned that these devices may grind away at the rice if left on, but there is no research evidence to support this claim. A small amount of flour-like substance will form 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 as the bin is being filled. If coning 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 uneven airflow through each portion of the grain bin. Most of the air will pass up the outside of the bin through the larger and cleaner grain. A level height should be maintained through the filling process. Once particle separation occurs, it is hard to correct even if the bin is later shoveled level.

Air temperature is important when drying rice. When air is being pushed through deep depths for prolonged periods of time, the air temperature should not exceed 105 degrees F (Fig. 8-4). If higher temperatures are used, the rice kernel can be overheated, resulting in low milling characteristics. Commercial dryers can use much higher air temperatures than on-farm dryers because the rice is subjected to heated air for shorter periods of time. Rice can be successfully dried on the farm, but different management techniques are necessary than when drying commercially.

Some of the main causes of problems that occur with on-farm drying are:

1. Hurrying the drying process to make room for freshly harvested rice.

2.Using drying temperatures that are too high, resulting in extremely low humidity drying air causing over-dried and stress-cracked rice and low head rice yields.

3. Attempting to dry with insufficient airflow, usually caused by excessive depth of high moisture rice.

4. Lack of attention after rice has been dried to at least 13 percent.

5. Harvesting rice with a moisture content in excess of 20 percent to be dried in on-farm facilities.

6. Inadvertently rewetting dried rice by aerating with high humidity air. Usually occurs if fans are run night and day with no addition of heat at night.

Suggested Steps for On-farm Rice Drying

1. Harvest rice at 20 percent or less and avoid attempting to dry rice on the farm if the moisture at harvest exceeds 20 percent.

2. Clean the rice to be dried as much as practical by adjusting harvesting equipment to minimize the amount of foreign material.

3. Determine the rice moisture content of incoming rice and avoid mixing rice of different moisture contents once its moisture content has reached 15 percent or less.

4. Place the rice harvested first in the drying bin at a depth of 6 to 12 feet. When layer drying, this depth is dependent on the initial moisture content of the rice and the capabilities of the fan.

5. Level the rice equally across the entire drying bin at the depth selected. It is very important to level the rice in order to equalize the pressure throughout all horizontal cross-sections of the bin to obtain uniform airflow.

6. Open air exits so that air can exhaust readily from the drying bin.

7. Turn on the fans as soon as the ducts or the perforated floor is covered with approximately 1 foot or more of rice.

8. If possible, do not hold wet rice in a bin, truck, combine hopper or grain cart longer than 12 hours without moving air through the container to cool the rice.

9. Measure the relative humidity and temperature of the ambient air to determine the maximum temperature setting of the heater.

10. Exercise extreme caution when rice kernel temperature exceeds 100 degrees F.

11. Dry high moisture rice in shallow batches until the rice moisture content is 15 percent or less. Then, deeper depths with lower airflow requirements are acceptable.

12. Drying time per batch is dictated by air flow rate, measured as cubic feet per minute (CFM) per hundredweight (cwt), temperature difference between air entering and leaving the rice, the moisture content of the ambient air, and the original moisture content of the rice.

13. The best way to reduce drying time is to increase airflow.

14. Once the rice has reached 15 percent moisture, move it to another bin where the depth can be increased and the airflow per cwt can be decreased. Continue drying by controlling relative humidity of the drying air.

15. Once the rice is 12.5 to 13 percent grain moisture through the entire depth of storage, fill the storage bin and level the grain surface.

16. Aerate to cool the grain kernels for the next few weeks when the humidity is below 60 percent and the air is cool (50 to 60 degrees F).

17. Do not operate fans when ambient temperature is below 32 degrees F.

18. Probe the bin periodically (once a week is ideal) for temperature or moisture variation.

19. Normally, the first place that moisture migration will occur is the center of the top layer. If there is any indication that moisture or temperature is increasing in this area or other areas, turn on the fans to cool and/or dry moistened rice.

20. Do not let any spoiled rice mix with good rice.

21. Periodic aeration may be necessary to counter extreme temperature changes during storage.