

# Bin Drying

George E. Miller & James F. Thompson

## Instrumentation requirements

Successful operation of bin dryers requires:

- a. Calibrated rice moisture meter.
- b. A high quality relative humidity indicator and a means to calibrate it.
- c. A high quality electronic thermometer.

## Clean before drying

The first step in bin drying is to put all green rice through a high efficiency aspirator and scalper before loading in the bin dryer. Fines reduce the air flow through rice, causing increased drying time and can cause wet spots.

## Fill depth

Rice moisture content limits the filling depth for a bin. High moisture rice requires high air flow rates to allow it to be dried quickly enough. For example, rice at 26% moisture needs at least 4 cfm/cwt. As rice depth in a bin decreases air flow increases and Table 1 shows the maximum fill depth for typical moistures.

**Table 1. Typical fill depths for bin drying rice.**

Moisture Content (% wet basis)	Depth of Rice (feet)
Below 18	Up to 20
18-20	10
20-22	8
22-24	6
24-26	5
26-28	4
28-30	3

Optimum harvest moisture for maximum head quality is about 24% for medium grain varieties, so typically a bin is filled to a 5' to 6' depth. After rice reaches 17-18%, put it through the aspirator again to remove fines, transfer it to another bin and continue drying.

Near the end of the season, final drying from 17% to 18% to storage moisture, slows because outside air temperatures are lower. Storage bins are also nearly full causing fans to produce less air flow (lower cfm/cwt). In order to finish drying the top layers in a bin in a reasonable time: 1) dry to 15% to 16% in the first stage, perhaps using some supplemental heat, and 2) fill top layers as shallow as possible.

## **Fan operation**

Operate fans only when relative humidity is low enough to produce drying. Humidity limits are determined by rice moisture and temperature and are listed in Table 2. Another way of determining when to operate fans is to operate them only when discharge air temperature is lower than ambient temperature (outside air temperature in the shade). Check discharge air temperature after fans have been on long enough for air temperature to stabilize.

During the first one or two nights it may be necessary to cool rice and to operate fans (without heat) even during high humidity conditions. This is particularly necessary if rice has a moisture above 22% and is warm from field heat or from heat generated by biological activity while stored in the harvester, bankout wagon, or transport truck. Suspect loads should be tested for high temperature during the truck load moisture content sampling.

Bin discharge air (with the fan on) should be tested regularly, especially at start up in the morning and at shut off at night for off odors and warm temperatures. Off odors indicate mold growth caused by slow drying. Speed drying by adding heat at night or increasing air flow by transferring rice and reducing rice depth or operating stirrers. A batch of moldy rice may need to be separated from unaffected product.

## **Stirrers**

Stirrers keep rice from packing and allow about 10% more air flow. They can also be used to level rice and break up wet spots. Fill the bin to a depth of at least 2-3 feet so that stirrers operate without whipping.

During drying, stirrers are operated continuously or once a day for a long enough time to completely stir the bin once. A gauge measuring pressure in the air plenum can be used to determine when the stirrers have operated long enough to minimize air pressure. Do not put high moisture rice on top of dry rice with stirrers in operation. Mixing undried rice from the field with rice below 18% can cause reduced head rice quality.

There are disadvantages with using stirrers and some operators choose not to use them. They add capital and operating cost and reduce the holding capacity of a bin. Some people prefer to invest in additional storage volume rather than buy stirrers. Experience in the Midwest indicates that they have greatest value when supplemental heat is added to the drying air.

## **Supplemental heat**

If weather conditions restrict drying hours, 10° to 15° F of supplemental heat can be added to reduce air humidity. When heat is used, test air temperature rise through fan and burner. Measure the air temperature in the shade (away from burner flame). Then drill a hole in the duct that will accommodate the measuring device between the burner and the bin. Fit the hole with a plug so it can be removed when taking temperature measurements. Maintain temperature rise at a constant 10-15° F. This may

require adjusting the gas pressure regulator, changing the burner orifice or replacing the burner. If drying capacity is limiting harvesting operations, drying air temperatures can be increased by more than 10-15° F if outside air temperature is less than 70° F, but do not exceed maximum daytime temperature of 85° F, whichever is lower, except if it is raining or foggy. Then maintain 10-15° F temperature rise up to 85° F and hold. Watch for condensation forming on an inside of roof, roof supports, and inside outer walls. If this occurs, reduce temperature rise until condensation stops. Additional fan capacity will also speed drying.

**Final moisture**

Dry to 12.5 to 14% moisture for safe storage as indicated in table 1 in the rice storage chapter. In some cases, rice may be stored through the winter at 15 to 16% moisture if rice is properly aerated and the rice temperature is kept below 50° F. This is not recommended, but may be necessary for very late harvested high moisture rice. If rice has been over dried, its moisture can be increased by operating fans when outside humidity is high. Table 2 describes the humidities that will add moisture without damaging rice.

Table 2. Outside air conditions for fan operation during drying and storage.

Outside air Temperature	Rice Moisture %	Outside air relative humidity %		
		DRY Turn fan on only below(2)	AERATE(1) Turn fan on between	ADD MOISTURE Turn fan on between
40 deg F	Over 20	93		
	19 – 20	92		
	18 – 19	87		
	17 – 18	83		
	16 – 17	78		
	15 – 16	73		
	14 – 15	67		
	13 - 14		57 – 66	66 - 92
	12 - 13			55 - 85
	11 - 12			50 - 78
	10 - 11		38 - 71	
	9 - 10		27 - 64	
50 deg F	Over 20	94		
	19 – 20	93		
	18 – 19	90		
	17 – 18	86		

50 deg F	16 - 17	82		
	15 - 16	76		
	14 - 15	70		
	13 - 14	61	61 - 69	69 - 92
	12 - 13			63 - 85
	11 - 12			53 - 78
	10 - 11			43 - 71
	9 - 10			33 - 64
<hr/>				
60°F	Over 20	95		
	19 - 20	94		
	18 - 19	91		
	17 - 18	88		
	16 - 17	83		
	15 - 16	78		
	14 - 15	72		
	13 - 14	64	64 - 72	72 - 92
	12 - 13			64 - 85
	11 - 12			56 - 78
	10 - 11			48 - 71
9 - 10			37 - 64	
<hr/>				
70°F	Over 20	96		
	19 - 20	94		
	18 - 19	92		
	17 - 18	88		
	16 - 17	84		
	15 - 16	80		
	14 - 15	73		
	13 - 14	67	67 - 73	73 - 92
	12 - 13			67 - 85
	11 - 12			60 - 78
	10 - 11			50 - 71
9 - 10			40 - 64	
<hr/>				
80°F	Over 20	97		
	19 - 20	95		
	18 - 19	92		
	17 - 18	89		
	16 - 17	84		
	15 - 16	81		
	14 - 15	75		
	13 - 14	64		75 - 92
	12 - 13			68 - 85
	11 - 12			64 - 78
	10 - 11			55 - 71

Do not  
aerate at  
high air  
temperature

	9 - 10		44 - 64
90°F	Over 20	97	
	19 - 20	95	
	18 - 19	93	
	17 - 18	90	
	16 - 17	86	Do not aerate at high air temperature
	15 - 16	82	
	14 - 15	76	
	13 - 14	72	
	12 - 13		77 - 92
	11 - 12		71 - 85
	10 - 11		66 - 78
	9 - 10		55 - 71
			45 - 64
100°F	Over 20	97	
	19 - 20	96	
	18 - 19	93	
	17 - 18	91	
	16 - 17	88	Do not aerate at high air temperature
	15 - 16	83	
	14 - 15	79	
	13 - 14	74	
	12 - 13		79 - 92
	11 - 12		73 - 85
	10 - 11		69 - 78
	9 - 10		61 - 71
			46 - 64

(1) This range can be safely expanded by 3% below and above if needed for short-term aeration. If hot spots are a problem fans and stirrers should be operated to cool rice and break up hot spots.

(2) Add heat to allow fan operation above these temperatures.