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Grain Drying Tools: Equilibrium Moisture Content Tables and Psychrometric Charts

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Introduction

Growers may be particularly concerned whether they should dry grain or not. In addition, they may question whether to use natural air or heated air in aerating grain in the bins. These two questions are essential because of the economic implications associated with them. This fact sheet attempts to provide a strategy that could help with the determination of grain drying systems and air heating level. The equilibrium moisture content (EMC) tables and the psychrometric charts will be used as tools throughout this fact sheet.

Grain contains dry matter as well as moisture at the time of harvest. In some cases, the grain moisture content (MC) is higher than that required for safe short-term or long-term storage. As a result, freshly harvested grain must be dried to safe moisture content levels before being stored or marketed. The safe MC for short-term and long-term storage of different crops is given in Table 1. Safe MC for short-term storage or long-term storage (one year or more) may be lower than that required for marketing. The variation of air temperature and humidity values during the storage period accounts for the differences between the long-term and short-term safe MC values. It should also be mentioned that safe storage MC in the warm temperature zone is lower than safe short-term storage in the cool temperature zone.

Grain Drying Basics

As mentioned earlier, there are instances when a large amount of moisture needs to be removed from the grain immediately after harvest to prevent spoilage and to maintain milling quality. Grain drying is accomplished through moisture movement from the grain to the air if the vapor pressure within the kernel is higher than the vapor pressure of the air surrounding it. In other words, the moisture moves from the kernel to the surrounding air and is transported to the atmosphere. Accordingly, air is normally used as the agent to dry grain. Large amounts of natural or

Table 1. Safe moisture content for grains in long- and short-term storage[1]

Grain Type	Long Term (One Year)	Short Term (30 to 60 Days)	
		Warm Temperatures	Cool Temperatures
Corn	12%	12%	15%
Sorghum	12%	12%	15%
Rough Rice	12%	12%	14%
Soybean	11%	11%	14%
Wheat	12%	12%	14%

[1] http://www.ag.ndsu.edu/extension-aben/documents/ae905.pdf

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heated air are passed through grain to achieve the previously mentioned levels of grain MCs for safe storage. The properties of air [temperature and relative humidity (RH)] and the rate of airflow passing through the grain determine the drying rate of the grain. Therefore, the rate of drying grain is controlled by the volume of air moving over the kernels and the vapor pressure difference between the air and the grain. Increasing air volume or air temperature will result in a decrease in drying time. However, rapid drying, using air with extremely high temperature, can produce stress on the kernels and form a crack or fissure in the kernel. Hence, special attention should be paid to the temperature and relative humidity of the drying air.

The following sections will explain the previously mentioned terms and concepts as well as provide examples that may prove useful in the decision-making process; i.e., if drying is indeed necessary after harvest and whether to use natural aeration or heated air.

Equilibrium Moisture Content

For a given air temperature and RH, grain moisture will eventually achieve a state of equilibrium with the environment. This grain property is called equilibrium moisture content (EMC). Thus, temperature and RH properties of the drying air determine the grain MC level. Tables A through E, presented at the end of this fact sheet, list the EMC of various grains including corn, soybean, sweet sorghum, rough rice and wheat in equilibrium with air at various temperatures and RHs.

To illustrate the use of the EMC tables, assume that air at 75% RH and 75°F temperature is being forced through corn kernels in the bulk. This corn will not dry below 15.7%, according to Table A. If air under the same RH (75%) and temperature (75°F) is being forced through soybean, rice and wheat for a long time, these grains will eventually reach the EMC of 15.2%, 15.2% and 14.6%, respectively.

Effects of Air Temperature Changes on Equilibrium Moisture Content

In the example given above, adding 10 degrees of supplemental heat to the air and keeping the air RH at 75% will dry corn to approximately 15.2% MC. In other words, increasing air temperature while maintaining RH level decreases the EMC value. This phenomenon occurs because increasing the air temperature increases its capacity to absorb moisture.

Effects of Relative Humidity Changes on Equilibrium Moisture Content

Equilibrium moisture content of air is also affected by RH, thus its drying capacity would be affected. Increasing the air RH from 75% to 85% at the same air temperature of 75°F increases the EMC of corn from 15.7% to 17.9%. As shown in Table A, the lowest attainable corn EMC is 7.1% at air temperature of 100°F and air RH of 25%. Conversely, the highest corn EMC of 22.9% is attained at air temperature of 35°F and air RH of 90%. It should be mentioned that drying slows and becomes more difficult when the drying air RH is near equilibrium.

Temperatures and Humidity

As mentioned earlier, nearly all grain-drying systems use air as a medium for removing moisture from the grain by evaporation. For moisture evaporation to take place, heat energy is required. In general, it takes approximately 1,100 BTUs (British thermal units) of heat to evaporate 1 pound of water. This would be 100% efficient; however, most on-farm or commercial drying operations are considerably less efficient. In air-drying systems, heat energy is supplied by the natural heat content of the air or by supplemental heating. The amount of moisture that air can absorb and transport as it moves through the grain column is dependent on its temperature and RH – along with some influences from air velocity, presence of fine materials other than grain, the distance the air travels and the MC of the grain. As the air moves through the grain column, it absorbs moisture and, thereby, loses some or all of its drying capabilities.

Psychrometric Chart and Its Use

A psychrometric chart presents physical and thermal properties of air in graphic form. It can be very helpful in grain-drying problems and in determining solutions. To determine air characteristics, two values of air characteristics should be known. Following, the intersection of these two known characteristics should be obtained on the psychrometric chart. Figure 1 shows a very simple form of the psychrometric chart. It shows eight air characteristics, namely (1) saturation temperature, (2) dew point temperature, (3) enthalpy, (4) relative humidity, (5) humidity ratio (moisture content), (6) wet bulb temperature, (7) volume of mixture and (8) dry bulb temperature. The dry bulb temperature, represented

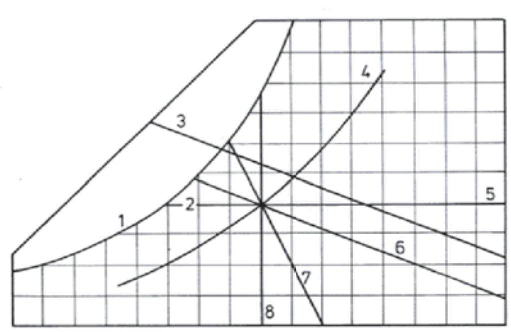

Figure 1. A simple form of a psychrometric chart

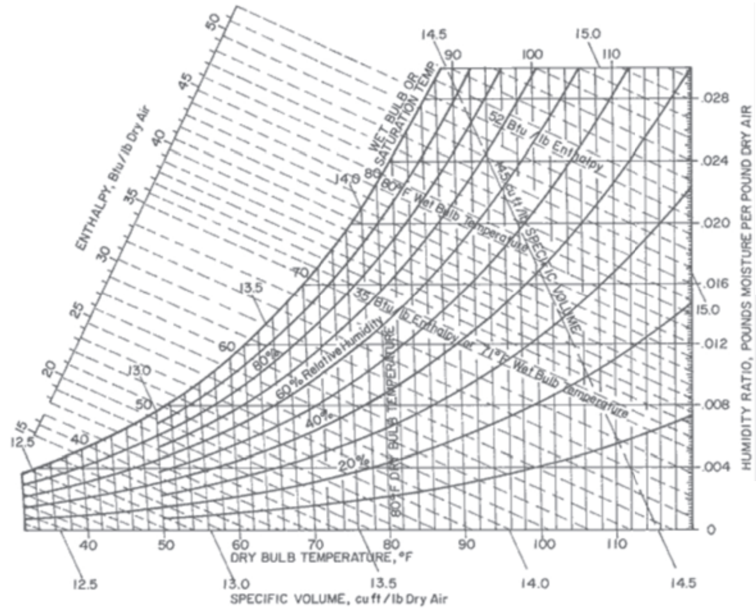

Figure 2. A psychrometric chart

by number 8, is located along the bottom horizontal axis. The wet bulb temperature, represented by number 6, is located along diagonal lines leading to scale readings at the upper, curved boundary marked as 1. The relative humidity, represented by curve 4, is running from left to right up through the chart. The intersection of the vertical dry bulb line and the diagonal wet bulb line will establish a “state point” for the measured air; then the relative humidity can be determined.

It should be noticed that increasing the dry bulb temperature while keeping the wet bulb temperature level would decrease the relative humidity value. For instance, if the ambient dry bulb temperature is 75°F and the wet bulb temperature is 69°F, the RH of the air would be 75% (see Figure 2). At this temperature and RH, rice could be dried to approximately 15.2% MC (Table D). If, however, 10 degrees of heat were added to increase the drying air to 85°F, the RH of the air would decrease to approximately 54%. The low humidity air will dry the rice to 11.4% MC, which is below the desired MC for safe storage. To attain the desired dried MC of 12.5%, the additional heat added to the air should only raise the temperature by 5 degrees to bring the drying air temperature to about 80°F with 63% RH.

Suggested Airflow Rate Corresponding to Grain Moisture Content

Airflow rates for drying vary from 0.5 CFM per bushel to more than 50 CFM per bushel for commercial or batch dryers. Most on-the-farm airflow rates for drying vary from 0.5 to 6 CFM per bushel, depending on the initial MC of the grain and the amount of heat added to the drying air. Recommended minimum airflow rates for different moisture content levels are shown in Table 2.

Table 2. Minimum airflow rate[2]

Moisture Content (% wet basis)	Minimum airflow rate (CFM/bushel)
11 to 13	0.5
13 to 15	1.0
15 to 18	2.0
18 to 20	3.0
20 to 22	4.0
22 and above	6.0

[2]http://www.uaex.uada.edu/Other_Areas/publications/PDF/MP297/9_storage.pdf

Suggested Heat Addition Corresponding to Drying Airflow Rate

When airflow rates are less than 1 CFM per bushel, add little or no heat. A rough guide for temperature increases through the heaters at various airflow rates is as follows:

- For an airflow rate of 1 to 2 CFM, limit the temperature rise to 6°F.
- For an airflow rate of 2 to 3 CFM, limit the temperature rise to 12°F.
- For airflow rates greater than 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 devices are used.

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

Estimation of the Amount of Excess Water and Drying Time

In estimating grain-drying time, the first step is to determine the number of pounds of dry grain (at the desired MC) produced from the wet grain (at the initial MC). This can be determined from the following formula:

$$\text{Final weight} = (\text{initial weight}) \times \frac{(100 - \text{initial moisture})}{(100 - \text{desired moisture})} \quad (1)$$

As an example, assume that you have 2,000 pounds of rice at MC of 22%, determine the number of pounds of water needed to be removed to get the MC to 13%. Note that the weight of rice at final MC of 13% is 45 pounds per bushel.

By applying the previous equation using the initial moisture content of 22%:

$$\text{Final weight} = 2{,}000 \times \frac{(100 - 22)}{(100 - 13)} \quad (2)$$

Final weight = 1,793 pounds = 1,793/45 = 39.8 bushels

The second step is to calculate the pounds of water that must be removed.

Pounds of water = 2,000 – 1,793 = 207 pounds

Therefore, the number of pounds of water to be removed per bushel = 207/39.8 = 5.19 pounds per bushel.

The third step is to estimate the drying time. The following formula can be used to estimate drying time:

$$\text{Drying time} = \frac{(H) \times (W)}{(AF) \times (1.07) \times (T_{out} - T_{in})} \quad (3)$$

Where:

- H is the heat required to vaporize 1 pound of water (1,100 BTU per pound)
- W is the excess amount of water per bushel to be removed (pound/bushel)
- AF is the airflow rate per bushel (CFM/bushel)
- T_{in} is the air temperature entering the drying bin (°F)
- T_{out} is the air temperature leaving the drying bin (°F)

For the previous example, assume that the air temperature entering the rice is 95°F. The air temperature leaving the rice at the top of the bin is 80°F. The fan is moving 4 cubic feet of air per minute per bushel through the rice. Determine the drying time.

Drying time can be calculated as follows:

$$\text{Drying time} = \frac{(1{,}100) \times (5.19 \text{ pounds per bushel})}{(4 \text{ CFM per bushel}) \times (1.07) \times (95 - 80)} \quad (4)$$

$$\text{Time} = \frac{(1{,}100) \times (5.19)}{(4) \times (1.07) \times (15)} = 88.93 \text{ hours} \quad (5)$$

Thus, it would take 88.93 hours to remove 5.19 pounds of water from a bushel of rice. To dry any number of bushels will require 88.93 hours as long as an airflow rate of 4 CFM per bushel is maintained. It should be mentioned that drying time estimates are quite dependent on outside air temperature and humidity. Thus, they should be used as a rough guide unless a constant temperature decrease through the rice is maintained.

Estimating Air Volume Through Grain

As mentioned earlier, air is the medium that transports moisture from the grain to the atmosphere. The volume of air moving through a column of grain is controlled by the type and size of fan and the resistance to airflow (static pressure) it meets. This static pressure varies depending on air velocity and the variety, depth, presence of fine materials other than grain and MC of the grain. Static pressure is usually measured with a manometer (see illustration in Figure 3), which is a clear plastic or glass “U” tube partially filled with colored water. A ruler is placed between the columns formed by the “U” tube. One end of the “U” tube is open to the atmosphere. The other end is attached to a rubber hose, which is placed over a small hole in the duct or plenum. Air is pressured through the hole in the duct, which will force the water column in the “U” tube to move so that there is a differential between the two levels of water in the tube. This difference in water levels is a measurement of the static pressure (inches of water), thus the reference to fans being capable of moving a certain number of cubic feet of air per minute at various inches of static pressure. Static pressure can also be measured using a Magnehelic differential pressure gage. Therefore, the power of a certain type of fan and the static pressure determine the amount of air to be delivered by that fan. Table 3 shows typical fan performance chart.

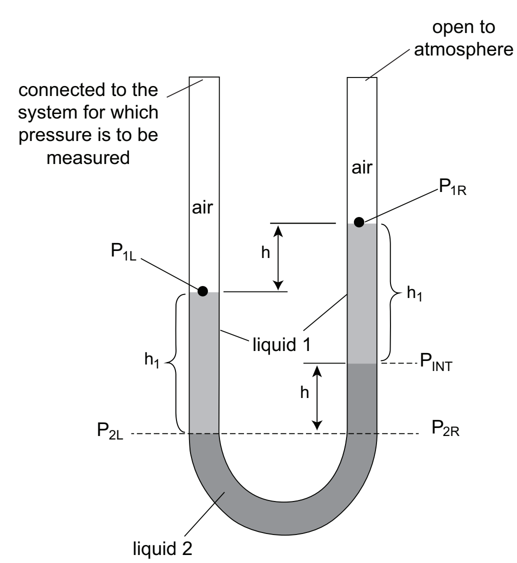

Figure 3. A schematic drawing of a manometer

Table 3. Typical centrifugal fan air delivery ratings, cubic feet per minute (CFM)[3]

Fan Motor Horsepower (hp)	Static Pressure (inches of water)									
	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
5.0	7,200	7,000	6,700	6,300	5,900	5,500	5,000	4,400	3,800	2,500
7.5	10,850	10,500	10,100	9,400	8,950	8,250	7,500	6,650	5,750	3,750
10.0	14,500	14,000	13,500	12,500	12,000	11,000	10,000	8,900	7,700	5,000
15.0	16,750	16,250	15,750	14,750	14,250	13,250	12,250	11,200	10,050	8,000
20.0	19,000	18,500	18,000	17,000	16,500	15,500	14,500	13,500	12,400	11,000

[3]Gardisser, D., and J. Langston. "Grain Drying and Psychrometric Chart." Cooperative Extension Service, University of Arkansas, Little Rock, Arkansas, USA.

Drying fans are rated to move certain volumes (cubic feet per minute) of air at various static pressures, as shown in Table 3. The lower the static pressure, the larger the volume of air a fan can move. These characteristics of pressure and volume vary depending on the type of fan. From Table 3, a 10-horsepower centrifugal fan will move approximately 14,500 CFM against zero static pressure; whereas, the same fan will deliver 11,000 CFM against the static pressure of 5 inches of water or 5,000 CFM against the static pressure of 9 inches of water. The air delivery ratings will vary depending on the design of the fan, but they will be approximately close to the figures listed in the table above. As the static pressure increases, the volume of air decreases. Thus, as the depth of the grain increases, the cubic feet of air per minute transported through the grain will decrease. Therefore, attention should be paid while selecting the drying depth in order to maintain the cubic feet per minute of air per bushel necessary to dry grain safely.

For instance, there are 4,000 bushels of 19% MC grain in a bin equipped with a 15-horsepower centrifugal fan. With the use of a manometer and the fan running, the static pressure was determined to be 5 inches of water. The centrifugal fan chart (Table 3) shows that a 15-horsepower fan will deliver 13,250 CFM of air. Does this fan unit deliver the required amount of minimum airflow rate?

By dividing the volume of air by the number of bushels in the bin, it is determined that air is being moved through the grain at a rate of approximately 3.3 CFM per bushel. This air volume meets the requirement of a minimum of 3 CFM per bushel for 19% MC bulk grain (see Table 2). If the bin had been equipped with a 7½-horsepower fan, the air volume at 5 inches of static pressure would have been 8,250 CFMs. This volume divided by 4,000 bushels would have provided approximately 2 CFM of air per bushel. It is determined that the airflow rate of 2 CFM per bushel for 19% MC bulk grain is less than the recommended minimum airflow rate as shown in Table 2. Under these conditions, consequently, the grain depth should be reduced resulting in fewer bushels of grain and a lower static pressure. Attempting to dry at the 2 CFM per bushel rate would mean slow drying and possible grain deterioration.

Grain Drying Methodology

It is imperative to know the parameters that can help determine the need for grain drying after harvest and if heated air is required or not. These parameters include grain type, grain initial MC, volume of bulk grain (number of bushels), the power of the fan, fan performance specifications (airflow rate vs. static pressure), the air wet and dry bulb temperatures and the target final (dried) grain MC.

The following steps provide a procedure to determine if drying is needed as well as whether or not to use heated air.

1. Measure the initial moisture content of grain to be dried.
2. Using a sling psychrometer (Figure 4), determine the wet and dry bulb temperatures.

Figure 4. A photo of a sling psychrometer

3. Using these temperatures, determine the relative humidity (RH) from the scales on the sling psychrometer or from a psychrometric chart.
4. Round the relative humidity and dry bulb temperature values to the nearest 5.

5. Determine the equilibrium moisture content (EMC) corresponding to air temperature and the RH from the EMC tables.
6. Determine the volume of air per minute (usually in cubic feet per minute or cfm) being moved by the fan from the fan performance chart corresponding to the static pressure. Refer to fan manufacturer's specifications and performance curves.
7. Check if the air volume exceeds the minimum airflow requirements (Table 2) of your grain's initial MC to accomplish drying.
8. If the EMC is found to be below the safe storage MC, then no heat will be needed – run fans with unheated air. If the EMC is found to be greater than the safe storage MC, heat will be needed to dry the grain to a safe storage moisture level.
9. Add 5 degrees of heat to the dry bulb temperature reading, and use psychrometric chart to determine the new RH. Note that the new dry bulb temperature is now 5 degrees greater than it was originally – the wet bulb temperature also increases slightly. (See the psychrometric chart in Figure 2.)
10. Determine the equilibrium moisture content of the grain for these new conditions. If the EMC is equal or slightly less than safe storage moisture content, then proceed with drying at this temperature. If the EMC is higher than for safe storage MC, determine the amount of additional heat needed.
11. Care should be used when temperatures exceed 100°F, particularly for rice, soybean and any grain saved for seeds.

Grain Drying Example

Assume that a producer has 4,000 bushels of 19% MC corn in a bin equipped with a 15-horsepower centrifugal fan. The measured static pressure is 5 inches. The wet bulb temperature is 70°F, and the dry bulb temperature is 75°F. The producer wants to reduce the corn MC to 12%.

1. Using a psychrometric chart or sling psychrometer, determine the relative humidity. In this case, it is 78% RH. (See psychrometric chart in Figure 2.)
2. From the EMC table, the EMC for corn is approximately 16.7% when the dry bulb temperature is 75°F and the RH is 78% (rounded to 80 percent; see Table A).
3. Using the fan chart (Table 3), determine the volume of air being moved by a 15-horsepower fan at 5 inches static pressure. This should be 13,250 CFM.
4. Divide the volume of air (13,250) by the number of bushels (4,000) to determine the volume of air being moved per bushel of corn (13,250/4,000 = 3.31 CFM/bu). This air unit volume meets the minimum requirement of 3 CFM per bushel for 19% grain. (See minimum airflow rates in Table 2.)
5. With air conditions described, the 19% MC bulk corn can be dried to 16.7% MC without heating the air. However, the drying process would be very slow, particularly when the corn approaches the 17% MC level. Under these conditions, with warm outside temperatures, corn could develop aflatoxin if drying is prolonged over a long period. Thus, fast drying is highly recommended.

Table A. Corn Equilibrium Moisture Content

	Relative Humidity (%)													
Temperature (°F)	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	9.3	10.3	11.2	12.1	13.0	13.9	14.8	15.7	16.6	17.6	18.7	19.8	21.2	22.9
40	9.1	10.0	10.9	11.8	12.7	13.5	14.4	15.3	16.2	17.1	18.2	19.3	20.7	22.3
45	8.8	9.8	10.6	11.5	12.3	13.2	14.0	14.9	15.8	16.7	17.7	18.9	20.2	21.8
50	8.6	9.5	10.4	11.2	12.0	12.9	13.7	14.5	15.4	16.3	17.3	18.5	19.8	21.4
55	8.4	9.3	10.1	11.0	11.8	12.6	13.4	14.2	15.1	16.0	17.0	18.1	19.3	20.9
60	8.2	9.1	9.9	10.7	11.5	12.3	13.1	13.9	14.8	15.7	16.6	17.7	18.9	20.5
65	8.0	8.9	9.7	10.5	11.3	12.0	12.8	13.6	14.5	15.3	16.3	17.4	18.6	20.1
70	7.9	8.7	9.5	10.3	11.0	11.8	12.6	13.4	14.2	15.0	16.0	17.0	18.2	19.8
75	7.7	8.5	9.3	10.1	10.8	11.6	12.3	13.1	13.9	14.8	15.7	16.7	17.9	19.4
80	7.6	8.4	9.1	9.9	10.6	11.4	12.1	12.9	13.7	14.5	15.4	16.4	17.6	19.1
85	7.4	8.2	9.0	9.7	10.4	11.2	11.9	12.6	13.4	14.3	15.2	16.2	17.3	18.8
90	7.3	8.1	8.8	9.5	10.3	11.0	11.7	12.4	13.2	14.0	14.9	15.9	17.0	18.5
95	7.2	7.9	8.7	9.4	10.1	10.8	11.5	12.2	13.0	13.8	14.7	15.6	16.8	18.2
100	7.1	7.8	8.5	9.2	9.9	10.6	11.3	12.0	12.8	13.6	14.5	15.4	16.5	17.9

6. An option is to consider adding heat to raise air temperature by 10 degree-points. This will raise the air dry bulb temperature to 85°F. From the psychrometric chart, the RH is determined to be approximately 58%.

7. From the EMC table, the EMC for corn at these air conditions (85°F and 60% RH) is approximately 12.6%. Thus, the additional heat to raise the air temperature by 10 degree-points is satisfactory to dry the corn to a safe storage MC.

Table B. Soybean Equilibrium Moisture Content

Temperature (°F)	Relative Humidity (%)													
	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	5.9	6.5	7.1	7.8	8.6	9.4	10.3	11.5	12.8	14.4	16.4	19.1	22.9	28.9
40	5.8	6.4	7.1	7.7	8.5	9.3	10.2	11.3	12.6	14.2	16.2	18.9	22.7	28.7
45	5.8	6.4	7.0	7.7	8.4	9.2	10.1	11.2	12.5	14.1	16.1	18.7	22.5	28.4
50	5.7	6.3	6.9	7.6	8.3	9.1	10.0	11.1	12.4	14.0	16.0	18.6	22.3	28.2
55	5.7	6.2	6.8	7.5	8.2	9.0	10.0	11.0	12.3	13.8	15.8	18.4	22.1	28.0
60	5.6	6.2	6.8	7.4	8.1	8.9	9.9	10.9	12.2	13.7	15.7	18.3	21.9	27.8
65	5.6	6.1	6.7	7.4	8.1	8.9	9.8	10.8	12.1	13.6	15.5	18.1	21.7	27.6
70	5.5	6.1	6.6	7.3	8.0	8.8	9.7	10.7	11.9	13.5	15.4	17.9	21.6	27.3
75	5.4	6.0	6.6	7.2	7.9	8.7	9.6	10.6	11.8	13.3	15.2	17.8	21.4	27.1
80	5.4	5.9	6.5	7.1	7.8	8.6	9.5	10.5	11.7	13.2	15.1	17.6	21.2	26.9
85	5.3	5.9	6.4	7.1	7.7	8.5	9.4	10.4	11.6	13.1	15.0	17.5	21.0	26.7
90	5.3	5.8	6.4	7.0	7.7	8.4	9.3	10.3	11.5	13.0	14.8	17.3	20.8	26.5
95	5.2	5.7	6.3	6.9	7.6	8.3	9.2	10.2	11.4	12.8	14.7	17.1	20.7	26.3
100	5.2	5.7	6.2	6.9	7.5	8.3	9.1	10.1	11.3	12.7	14.5	17.0	20.5	26.1

Table C. Sorghum Equilibrium Moisture Content

Temperature (°F)	Relative Humidity (%)													
	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	11.5	12.1	12.7	13.3	13.8	14.4	15.0	15.6	16.3	17.0	17.8	18.8	19.9	21.4
40	11.3	11.9	12.5	13.1	13.6	14.2	14.8	15.4	16.1	16.8	17.6	18.6	19.7	21.2
45	11.1	11.7	12.3	12.9	13.4	14.0	14.6	15.3	15.9	16.6	17.5	18.4	19.6	21.1
50	10.9	11.5	12.1	12.7	13.3	13.8	14.4	15.1	15.7	16.5	17.3	18.2	19.4	20.9
55	10.7	11.3	11.9	12.5	13.1	13.7	14.3	14.9	15.6	16.3	17.1	18.1	19.2	20.8
60	10.5	11.2	11.7	12.3	12.9	13.5	14.1	14.7	15.4	16.1	17.0	17.9	19.1	20.6
65	10.4	11.0	11.6	12.2	12.7	13.3	13.9	14.6	15.2	16.0	16.8	17.8	18.9	20.5
70	10.2	10.8	11.4	12.0	12.6	13.2	13.8	14.4	15.1	15.8	16.7	17.6	18.8	20.3
75	10.0	10.6	11.2	11.8	12.4	13.0	13.6	14.3	14.9	15.7	16.5	17.5	18.7	20.2
80	9.9	10.5	11.1	11.7	12.3	12.9	13.5	14.1	14.8	15.6	16.4	17.4	18.5	20.1
85	9.7	10.3	10.9	11.5	12.1	12.7	13.3	14.0	14.7	15.4	16.3	17.2	18.4	20.0
90	9.6	10.2	10.8	11.4	12.0	12.6	13.2	13.8	14.5	15.3	16.1	17.1	18.3	19.8
95	9.4	10.0	10.6	11.2	11.8	12.4	13.1	13.7	14.4	15.2	16.0	17.0	18.2	19.7
100	9.3	9.9	10.5	11.1	11.7	12.3	12.9	13.6	14.3	15.0	15.9	16.9	18.0	19.6

Table D. Rice Long Grain Equilibrium Moisture Content

	Relative Humidity (%)													
Temperature (°F)	25	30	35	40	45	50	55	60	65	70	75	80	85	90
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	11.3	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

Table E. Wheat Durum Equilibrium Moisture Content

	Relative Humidity (%)													
Temperature (°F)	25	30	35	40	45	50	55	60	65	70	75	80	85	90
35	8.3	8.9	9.6	10.2	10.9	11.5	12.2	13.0	13.8	14.7	15.8	17.1	18.8	21.3
40	8.2	8.8	9.5	10.1	10.7	11.4	12.1	12.8	13.7	14.6	15.7	17.0	18.7	21.1
45	8.1	8.8	9.4	10.0	10.6	11.3	12.0	12.7	13.5	14.4	15.5	16.8	18.5	20.9
50	8.0	8.7	9.3	9.9	10.5	11.2	11.9	12.6	13.4	14.3	15.4	16.6	18.3	20.7
55	7.9	8.6	9.2	9.8	10.4	11.1	11.7	12.5	13.3	14.2	15.2	16.5	18.1	20.5
60	7.8	8.5	9.1	9.7	10.3	10.9	11.6	12.3	13.1	14.0	15.1	16.3	18.0	20.4
65	7.8	8.4	9.0	9.6	10.2	10.8	11.5	12.2	13.0	13.9	14.9	16.2	17.8	20.2
70	7.7	8.3	8.9	9.5	10.1	10.7	11.4	12.1	12.8	13.7	14.7	16.0	17.6	20.0
75	7.6	8.2	8.8	9.4	10.0	10.6	11.2	11.9	12.7	13.6	14.6	15.8	17.4	19.8
80	7.5	8.1	8.7	9.3	9.9	10.5	11.1	11.8	12.6	13.4	14.4	15.7	17.3	19.6
85	7.4	8.0	8.6	9.2	9.8	10.4	11.0	11.7	12.4	13.3	14.3	15.5	17.1	19.4
90	7.3	7.9	8.5	9.1	9.6	10.2	10.9	11.5	12.3	13.1	14.1	15.3	16.9	19.2
95	7.2	7.8	8.4	9.0	9.5	10.1	10.7	11.4	12.2	13.0	14.0	15.2	16.7	19.0
100	7.2	7.7	8.3	8.8	9.4	10.0	10.6	11.3	12.0	12.8	13.8	15.0	16.5	18.8

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