# STORING AND DRYING SOYBEANS TO MAINTAIN QUALITY

Pre-harvest damage to mature soybean seed occurs periodically throughout much of the US soybean belt. This happens when harvest of the mature crop is delayed by lengthy periods of rainy weather that often is accompanied by warm air temperatures. These conditions promote proliferation of seed-rotting fungi that are present on mature pods and grow through the pod and infect the seed (Sweets, Univ. of Missouri). This results in moldy, discolored seed that are docked when delivered to the elevator.

Once these weathered seed are harvested and stored in on-farm facilities, the period of concern is not over just because these seed have been removed from the adverse field environment. Weathered/damaged soybeans that are harvested will carry with them to the storage facility the agents–i.e. pathogenic organisms–that caused the damage in the field. Thus, if the storage facility is not equipped to maintain conditions that will prevent these field fungi plus storage fungi from proliferating during storage, then the damage that was occurring in the field before harvest will only get worse in storage.

The following narrative summarizes how proper management of seed storage facilities can ensure that the situation does not deteriorate further during storage after harvest. Click here (Sadaka, Univ. of Ark.) for the reference resource that was used to compile the following points.

When in storage, soybeans are dried to get rid of the excess moisture in the stored seed so that there is a lessened chance of activity by pathogens that are on the seed. Fungal activity in stored soybeans is enhanced by high moisture levels and high humidity. Soybeans are typically dried to a seed moisture content of 12 to 13% to prevent this fungal activity. The quality of the drying air that is used in the process determines the moisture content in the stored seed.

A specific volume of air at a certain temperature can hold a specific amount of moisture. Thus, the drying capabilities of air entering the storage bin can be increased by adding energy (heat) to that air or by passing larger volumes of ambient air over the stored seed. The below Table 1 contains minimum air flow rates (cubic ft. per minute per bushel–cfm/bu) for drying soybeans with a known moisture content.

**Table 1. Minimum airflow rates for drying soybeans.**

| Measured seed moisture content | Minimum airflow rate |
|---|---|
| % | cfm/bu |
| 18-20 | 3.0 |
| 15-18 | 2.0 |
| 13-15 | 1.0 |
| 11-13 | 0.5 |

Click here for reference source (Sadaka, Univ. of Ark.).

The equilibrium moisture content (EMC) of soybean seed in a storage bin is the moisture content that seed in the bin will maintain at a given air temperature (AT) and relative humidity (RH). See the below Table 2 for soybean EMC's at selected AT's and RH's, and note the AT and RH necessary to maintain EMC's in the 12-13% range.

**Table 2. Soybean equilibrium moisture content (EMC) at selected AT's and RH's.**

| | RH (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| AT (°F) | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| 40 | 6.4 | 7.7 | 9.3 | 11.3 | 14.2 | 18.9 | 28.7 |
| 50 | 6.3 | 7.6 | 9.1 | 11.1 | 14.0 | 18.6 | 28.2 |
| 60 | 6.2 | 7.4 | 8.9 | 10.9 | 13.7 | 18.3 | 27.8 |
| 70 | 6.1 | 7.3 | 8.8 | 10.7 | 13.5 | 17.9 | 27.3 |
| 80 | 5.9 | 7.1 | 8.6 | 10.5 | 13.2 | 17.6 | 26.9 |
| 90 | 5.8 | 7.0 | 8.4 | 10.3 | 13.0 | 17.3 | 26.5 |
| 100 | 5.7 | 6.9 | 8.3 | 10.1 | 12.7 | 17.0 | 26.1 |

Click here for reference source (Sadaka, Univ. of Ark.).

The preferred moisture content for soybean seed at harvest is about 14%. A producer with storing and drying capability can harvest at higher moisture contents to avoid potential weathering damage to seed that are still in the field when unfavorable weather patterns occur.

To avoid soybean seedcoat cracking while in storage, keep the RH of drying air above 40%. This places a heavy emphasis on careful monitoring of drying air temperature since hotter air will lower the RH of that air.

The proper temperature of drying air is determined by the final intended use of the stored seed; e.g., seed that will be used for oil and food production can be dried at temperatures no higher than 130°F, while seed that will be used for planting should be dried at air temperatures no greater than 100°F.
Batch and continuous-flow driers should not be used for drying soybean seed because the heat input may be too high. Thus, bin drying systems–natural-air and low-temperature drying–are likely the best drying options for soybeans.

Natural-air drying (unheated air) can be used under favorable weather conditions that will allow a net moisture transfer from the stored soybeans to the passing air. A general rule is that natural air can be used to achieve and maintain EMC in a normal year if air temperature is above 60°F and RH is below 75%. Thus, natural-air drying is sensitive to prevailing weather conditions.

Dr. Paul Jasa of the Univ. of Nebraska used a grain drying program to calculate the estimated time it would take to dry soybeans using natural unheated air at 1 cfm/bu of grain in a bin. The results are shown in Table 3. Note how the higher temperature and lower humidity of drying air reduces the time to dry soybean seed to the desired 13% level. Note also the length of time needed to dry soybeans that are above 15% seed moisture content, especially with more moist (higher RH) drying air.

**Table 3. Days required to dry soybeans to 13% moisture with 1 cfm/bu airflow using natural, unheated air at temperatures of 60, 50, and 40°F with indicated RH. Assumes exhaust air has 85% RH.**

| | **Initial Seed Moisture Content (%)** | | | | | |
|---|---|---|---|---|---|---|
| **Air Temp.*** | **14** | **15** | **16** | **17** | **18** | **19** |
| **60°F** | Drying Time (days)** | | | | | |
| 60% RH | 4.6 | 9.2 | 14.0 | 18.9 | 23.9 | 29.0 |
| 50% RH | 3.4 | 6.9 | 10.5 | 14.1 | 17.8 | 21.7 |
| 40% RH | 2.7 | 5.4 | 8.2 | 11.1 | 14.1 | 17.1 |
| 30% RH | 2.2 | 4.4 | 6.7 | 9.1 | 11.5 | 14.0 |
| **50°F** | Drying Time (days)** | | | | | |
| 60% RH | 6.0 | 12.1 | 18.3 | 24.7 | 31.3 | 38.0 |
| 50% RH | 4.3 | 8.7 | 13.2 | 17.8 | 22.5 | 27.4 |
| 40% RH | 3.4 | 6.8 | 10.3 | 13.9 | 17.6 | 21.4 |
| 30% RH | 2.8 | 5.6 | 8.4 | 11.4 | 14.4 | 17.5 |
| **40°F** | Drying Time (days)** | | | | | |
| 60% RH | 6.7 | 13.5 | 20.5 | 27.7 | 35.0 | 42.5 |
| 50% RH | 4.9 | 10.0 | 15.1 | 20.4 | 25.9 | 31.4 |
| 40% RH | 3.9 | 8.0 | 12.1 | 16.3 | 20.7 | 25.1 |
| 30% RH | 3.3 | 6.6 | 10.0 | 13.5 | 17.1 | 20.8 |

*Indicated temperatures are the average of high and low for the day.
**Drying time is proportional to air flow. To estimate drying time for airflow values other than the 1 cfm/bu used here, divide the drying time in the table by the cfm/bu for the bin. For example, if the airflow is 1.25 cfm/bu and the estimate in the table is 10 days, the estimated drying time will be 10 days/1.25 = 8 days.

Low-temperature drying may be needed in a cool, wet fall when air temperature is low and RH is relatively high. With this technique, the drying air is heated to 10° to 20°F above ambient conditions. This drying technique requires the same bin components (i.e., perforated floor, drying fan, grain spreader, sweep auger, and unloading auger) as natural-air drying. This drying technique will dry grain quicker; thus, it is relatively economical since it is likely that more energy will be required to run drying fans than to heat the air.

Regardless of drying technique used, RH of the drying air should be >40% when drying soybeans. Thus, the 30% RH in Table 3 should be ignored for soybean drying. Since RH of the drying air is dependent on the temperature of that air, drying air temperature should be closely monitored during the drying process.

It is generally accepted that stored soybeans should be kept at a temperature no greater than 40°F to prevent damaging fungal activity.

The grain bin fans that are used to circulate air through grain in the storage bin determine the rate of air circulation. Click here for a Univ. of Arkansas publication that provides details for the selection, performance, and maintenance of grain bin fans.

There is little if any remedy for the damage to soybean seed that will occur when adverse weather conditions prevent timely harvest of mature seed. However, following proper storing and drying techniques will prevent further deterioration of seed after they are harvested and placed in storage facilities.

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