GRAIN QUALITY Task Force
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Drying Soybeans Requires Special Considerations

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Field and weather conditions in the fall are usually such that field drying is sufficient to reduce the moisture content in soybeans to a safe storage level. However, wet and cool conditions have already hampered some of the soybean harvest this fall especially in fields that are to be planted with winter wheat. Enclosed is a brief review of some of the basics to consider when the moisture content of mature soybeans remains at 16 - 20% for extended periods.

General Recommendations

Provided that soil conditions support equipment and soybeans are sufficiently defoliated, high moisture beans up to 18% can be successfully harvested and dried. Essentially, all grain drying methods (see Grain Quality Fact Sheet 15) are adaptable with some restrictions on the use of heat and handling practices. Good quality soybeans should be dried to 13.5 - 14% for winter storage, and 12 - 12.5% if they are to be carried into the summer. If quality out of the field is poor, the moisture content should be reduced by an additional 0.5 - 1.0 percentage point.

Too much heat while drying soybeans causes excessive seed coat cracking, which results in splits. Although not a dockage factor below 10%, seed coat cracking destroys the integrity of the seed and its protection during storage and handling. The key factor in avoiding splits is to keep the relative humidity of the drying air above 40%.

This is a significant limitation on heat input and drying capacity. For example, 50^{o}F outside air with 80% relative humidity can only be heated to 70^{o}F in order to maintain humidity above 40%.

High Temperature Drying

The heat input in high temperature batch, continuous-flow and bin dryers can be restricted either by using short heat-on cycles, or changing the burner jets to a low-fire type. The resultant temperature rise from ON/OFF cycling is proportional to the percent of ON time.

For example, a burner with a minimum continuous fire rate of 40^{o}F rise will average about 20^{o}F rise if fired only 50% of the time. The same unit will average 10^{o}F rise if fired only 25% of the total ON/OFF cycle time. Utilization of a proportional timer that allows calibration of the total cycle by turning a percent dial can be used to control the length of the fire cycle. If splits are not as much of a concern, drying air temperatures should be limited to 120 - 140^{o}F to avoid heat damaged beans.

Low Temperature Drying

Natural air above 60^{o}F and below 75% humidity will require no supplemental heat to remove 2 to 3 points of moisture from soybeans.

However, natural air and low-heat drying in deep bins are slow processes. For example, a 24 ft diameter bin filled to 16 ft depth with 18% moisture soybeans will require about 23 days to complete drying to 13% during an average weather year. This assumes a 7.5 HP fan delivering 1.4 cfm/bu and a temperature rise of 10^{o}F.

Drying speed can only be increased by reducing the depth in the bin (which increases the airflow per bushel), and/or by adding more than 10^{o}F of heat. When adding supplemental heat, the 40% humidity requirement becomes the limiting factor. The need for drying capacity can be further reduced by only harvesting during the afternoon hours when moisture contents are closer to 16%.

Fans should generally be operated continuously as long as the average 24 hour air conditions are below 70 - 75% relative humidity and soybean moistures are above 15%. Generally, only little rewetting occurs, and then only in the bottom 6 to 18 inches. The balance of good weather during the day or week more than off-sets short high-humidity periods during the night, or 1 to 2 days of drizzle. Additionally, heat generated by the fan motor reduces the outside air relative humidity by 10 to 20 percentage points.

For additional information refer to AE-84 Drying Soybeans with Heated and Unheated Air available from your local Cooperative Extension Service Office.

corn cover the perforated floor. Cooling occurs over about 48 hours with ambient air at a full bin airflow rate of 0.5 - 1.0 cfm/bu. Cooling the hot corn too slowly because of undersized fan capacity can lead to spoilage. Also, condensation can become a storage problem because the corn remains in the bin and wetter kernels are not remixed.

High-Low Temperature (2-stage) Drying - High temperature drying followed by transferring hot grain at 19-23% moisture content into a natural air drying bin appears to be a little known practice. This two-stage drying operation reduces fuel costs and increases drying capacity more than any other combination drying operation. According to research conducted in Minnesota, total fuel and electric energy consumption can be reduced by 40% to 60% for corn with initial moisture contents of 24% to 28%.

The hot corn is cooled in the bin as the low temperature drying front is started. Cooling will remove about 1 point of moisture. Sizing the fans to the proper airflow and operating the fans continuously until the top layer drops below 18% moisture and 35^{o}F is critical (see Table 1).

Table 1. Recommended airflow rates for corn transferred hot into a natural air drying bin.

Airflow (cfm/bu)	Hot Corn Moisture (%)
0.75	19 - 20
1.00	20 - 21
1.25	21 - 22
1.50	22 - 23

Choosing between in-bin cooling and high-low 2-stage drying can be based on the break-even costs between propane and electricity. Because in-bin cooling requires high-temperature drying to 16-17% first, more propane than electricity is used in drying. Conversely, more electricity is used during high-low 2-stage drying than in-bin cooling.

Table 2. Break-even costs of propane (cents/ gallon) for drying corn with initial moisture contents of 24% to 28%.

cents/kWh	24%	26%	28%
4	22.5	21	20
6	32	30	27.5
8	45	40	36

Thus, if the propane charge is higher than the break-even table value, high-low 2-stage drying is cheaper. On the other hand, if propane is cheaper than the table values, high temperature drying followed by in-bin cooling is favored.

Table 3. Break-even costs of electricity (cents/ kWh) for drying corn with initial moisture contents of 24% to 28%.

cents/gallon LP	24%	26%	28%
40	7	8	9
60	11	12	13
80	14.5	16	17.5

Thus, if the electric charge is higher than the break-even table value, high temperature drying followed by in-bin cooling is favored. On the other hand, if electric charges are cheaper than the table values, high-low 2-stage combination drying is favored.

Specialty Grains

Specialty grains such as food-grade white and yellow as well as high-amylose corn have to be handled much more delicately than regular commercial corn. Operating conventional drying equipment with the same temperature settings assures poor product quality. Field drying below 20% moisture and applying as little heat as possible are musts to minimize stress-cracking and/or denaturization of proteins. In addition, combination drying and multistage drying should be implemented as the preferred drying methods (see above).