Grain Drying

AE-701 (Revised), November 1994

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Grain drying, as used in this publication, refers to the removal of some of the moisture from grain by mechanically moving air through the grain after it has been harvested. Grain in the field dries naturally as the crop matures, giving up moisture to the air until the grain moisture is in equilibrium with the moisture in the air (equilibrium moisture content). Conditions become less favorable for grain to dry to moisture contents considered safe for storage as the harvest is delayed into late fall.

Drying Advantages and Disadvantages

Grain drying has several advantages and disadvantages.

Advantages include:

- Increases quality of harvested grain by reducing crop exposure to weather.
- Reduces harvesting losses, including head shattering and cracked kernels.
- Reduces dependency on weather conditions for harvest.
- Allows use of straight combining for small grains.
- Reduces size and/or number of combines and other harvest-related equipment and labor required due to extending harvest time.
- Allows more time for post-harvest field work.

Disadvantages include:

- Original investment for drying equipment and annual cost of ownership.
- Operating costs for fuel, electricity and labor.
- Extra grain handling required may result in further investment for equipment.

Recommended Storage Moisture Contents and Estimated Allowable Storage Times

The length of time grain can be stored without significant deterioration is determined by temperature and the moisture content at which it is stored. Table 1 shows the maximum recommended moisture content for storage with aeration of some typical North Dakota grains. Short-term storage generally refers to storage under winter conditions while long-term storage considers the effect of summer conditions. Grain with damaged kernels or with significant amounts of foreign material needs to be stored at a 1 to 2 percentage points lower moisture content than sound, clean grain.

Table 1. Maximum Recommended Moisture Contents of Selected Clean, Sound Grains for Storage with Aeration in North Dakota.

	Short term (less than 6 months)	Long term (more than 6 months)
Barley	14 %	12 %
Corn	15.5	13
Edible Beans	16	13
Flax seed	9	7
Millet	10	9
Oats	14	12
Rye	13	12
Sorghum	13.5	13
Soybeans	13	11
Non-Oil Sunflower	11	10

Oil Sunflower	10	8
Wheat	14	13

Grain can be stored at a higher moisture content without significant fungus development when stored at colder temperatures. Table 2 shows the relationship between moisture and temperature and its effect on allowable storage time for cereal grains.

Table 2. "Approximate" Allowable Storage Time (days) For Cereal Grains.

M.C.	Temperature (�F)					
(%)	30�	40�	50�	60�	70�	80�
14	*	*	*	* 200	140	
15	*	*	* 240	125	70	
16	*	* 230	120	70	40	
17	* 280	130	75	45	20	
18	* 200	90	50	30	15	
19	* 140	70	35	20	10	
20	*	90	50	25	14	7
22 190	60	30	15	8	3	
24 130	40	15	10	6	2	
26	90	35	12	8	5	2
28	70	30	10	7	4	2
30	60	25	5	5	3	1

Based on composite of 0.5 percent maximum dry matter loss calculated on the basis of USDA research at Iowa State University; Transactions of ASAE 333-337, 1972; and "Unheated Air Drying," Manitoba Agriculture Agdex 732-1, rev. 1986.
*Approximate allowable storage time exceeds 300 days.

The allowable storage time for corn has been established to be the time until a 0.5 percent dry matter reduction is reached. At that point there will be a reduction of one grade. Storage life is cumulative. If half of the storage life is used before the grain is dried, only half of the indicated storage time at the lower moisture content is available after the grain has been dried.

A rough estimate of storage life for oil crops might also be made based on the values for corn using an adjusted moisture content calculated using the equation:

$$\text{Comparable Corn Moisture Content} = \frac{\text{Oil Seed Moisture Content} \times 100.}{100 - \text{Seed Oil Content}}$$

For example, oil sunflower at 12.0 percent moisture content is comparable to corn at 20 percent moisture content.

$$\text{Comparable Corn Moisture Content} = \frac{12}{100 - 40} \times 100 = 20\%$$

Influence of Drying Conditions

Airflow rate, air temperature and air relative humidity influence drying speed. In general, higher airflow rates, higher air temperatures and lower relative humidities increase drying speed.

Raising the temperature of the drying air increases the moisture-carrying capacity of the air and decreases the relative humidity. As a general rule of thumb, increasing the air temperature by 20 degrees Fahrenheit (F) doubles the moisture-holding capacity of air and cuts the relative humidity in half.

The drying rate depends on the difference in moisture content between the drying air and the grain kernel. The rate of moisture movement from high moisture grain to low relative humidity air is rapid. However, the moisture movement from wet grain to moist air may be very small or nonexistent. At high relative humidities, dry grain may pick up moisture from the air.

The airflow rate also affects drying rate. Air carries moisture away from the grain, and higher airflow rates give higher drying rates. Airflow is determined by fan design and speed, fan motor size and the resistance of the grain to airflow. Deeper grain depths and higher airflow rates cause higher static pressures against the fan. Higher static pressures decrease fan output.

As air enters the grain, it picks up some moisture, which cools the air slightly. As air moves through a deep grain mass, the air temperature is gradually lowered and relative humidity increased until the air approaches equilibrium with the grain. If the air reaches equilibrium with the grain, it passes through the remaining grain without any additional drying. If high relative humidity air enters dry grain, some moisture is removed from the air and enters the grain. This slightly dried air will begin to pick up moisture when it reaches wetter grain. Air in a 12 to 16 inch grain column does not reach equilibrium with the grain.

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Types of Dryers and Drying
Energy, Quality, Fire, Moisture and Fans
Heaters, Costs, Safety and Managing Stored Grain

AE-701 (Revised), November 1994

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