COOLING STORED GRAIN TO PREVENT SPOILAGE IN THE TOP LAYERS

Circular 764

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Stored grain often molds and cakes during fall and winter, even in weathertight bins. Such spoilage usually forms a bowl-shaped mass ranging from 1 to 2 feet deep at the top center of the bin and becoming thin or disappearing altogether at the side walls.

The reason grain may spoil during these seasons is that moisture content tends to increase in the surface layers — often as much as 4 to 6 percentage points.

This accumulation of moisture in the surface layers may occur even when grain is stored below a safe moisture level. In such cases, the reason for this accumulation of moisture is that water vapor "migrates" from various parts of the bin and collects in the surface layers.

**Why Moisture Migrates**

During fall and early winter, grain near the walls and surface of the bin cools rapidly, but grain at the center remains warm (Fig. 1). Because of this difference in temperature, moisture slowly but steadily moves from the warmer to the cooler areas — from grain at the center of the bin to grain near the surface.

During fall and early winter, grain near the walls and surface of the bin cools fast, while grain at the center stays warm. This difference in temperature causes moisture to move from the warm to the cool areas and accumulate there. By spring, this accumulation of moisture causes grain in the top layers to mold and cake.

(Fig. 1)
During spring and summer, moisture tends to move in the reverse direction, because grain near the walls and surface warms faster than grain at the center of the bin. But by the time this occurs, the surface grain has usually molded and caked.

How to Control Moisture Migration

The only way to control this migration of moisture is to prevent large differences in temperature within the grain. The most effective way of doing this is by cooling.

Cooling involves drawing cold air from outside the bin and circulating it through the grain. *Air is drawn downward through the grain,* not upward, as is done when grain is artificially dried. In this way, warm, moist air is expelled directly from the bin instead of being forced to the surface where the grain is cold and where condensation is likely to occur.

ARRANGEMENT FOR COOLING GRAIN IN A RECTANGULAR BIN.
The air duct itself or inlets into the air duct should extend to within 4 feet of the end walls.
Cooling is most effective when it is started in late November or early December and continued uninterruptedly for 3 to 6 weeks.

CAUTION: This process is not intended to dry grain. Cooling is done only to prevent moisture from collecting in the surface layers.

**Equipment Used in Cooling**

Equipment used in cooling consists of a motor-driven fan and an air duct.

**Motor and fan**

The motor-driven fan has to be selected according to the *quantity* and *depth* of grain stored. In buying your fan, then, you will have to consider volume of delivery (cubic feet of air a minute delivered), which depends on the quantity of grain stored, and static pressure (the resistance this volume of air meets), which depends on the depth of grain stored.

Volume of delivery can safely be assumed to be about 1/25 cubic foot a minute for each bushel of grain stored. This means that if you are going to store 3,000 bushels, you will need a fan that will deliver at least 120 cubic feet a minute.

The depth at which grain is stored will, of course, vary from time

![Diagram of Cooling Grain in a Circular Bin](image-url)
to time, so the soundest procedure is to assume that the bin will be completely filled every year.

Knowing, then, the volume of delivery and the height of the bin, you can see from this table how much static pressure your fan will have to overcome:

<table>
<thead>
<tr>
<th>Depth of grain</th>
<th>Static pressurea</th>
<th>corn and soybeans</th>
<th>wheat and oats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 20 feet</td>
<td>¾ inch</td>
<td>¾ inch</td>
<td></td>
</tr>
<tr>
<td>20 to 30 feet</td>
<td>¼ inch</td>
<td>¼ inch</td>
<td></td>
</tr>
<tr>
<td>30 to 40 feet</td>
<td>⅜ inch</td>
<td>1⅛ inches</td>
<td></td>
</tr>
<tr>
<td>40 to 50 feet</td>
<td>½ inch</td>
<td>1¾ inches</td>
<td></td>
</tr>
</tbody>
</table>

* Inches, water gage, based on a volume of delivery of 1/25 cubic foot a minute for each bushel of grain stored.

### The air duct

Arrangements for air ducts for rectangular, circular, and silo-type bins are shown in Figs. 2, 3, and 4. These air ducts can be made out of wood or metal. If you prefer a metal one, compare the cost of making and buying one — the difference may be slight.

The cross-sectional area of the air duct has to be at least 1 square foot for each 1,000 cubic feet of air a minute delivered. A 4-inch-diameter circular air duct is satisfactory for a bin with a capacity of 2,000 bushels or less; a 6-inch-diameter circular air duct is satisfactory for a bin with a capacity of 5,000 bushels or less.

If you make an air duct out of metal, choose a heavy-gage pipe, and drill, cut, or punch inlets in it. These inlets should be about ⅛ inch in diameter so that grain will not plug or sift into the air duct. If the inlets are made larger, a fine-mesh screen should be placed around the air duct. Usually, inlets need not be cut or drilled into wooden air ducts — slats under them may provide adequate inlets (Fig. 5).

Air may be taken in at the top of the bin through screened louvers (Fig. 2), openings under the eaves (Fig. 3), or hooded openings in the roof (Fig. 4).

The total area of the inlets, as well as the total area of the air intakes, should be at least twice as great as the cross-sectional area of the air duct. But in any case, the total area of the inlets must equal at least 10 percent of the surface area of the air duct.
ARRANGEMENT FOR COOLING GRAIN IN A SILO-TYPE BIN. Air can be drawn into the collector which is connected to the fan by an air duct that has no inlets. A perforated oil drum serves well as a collector. (Fig. 4)
WOODEN AIR DUCT, only one of the many shapes that it may take. Usually, inlets need not be drilled into a wooden air duct — slats under them may provide adequate inlets. (Fig. 5)

In rectangular and silo-type bins, the air duct must be installed before the bin is filled. In small square and circular bins, the air duct can be installed after the bin is full by using a home-type vacuum cleaner to suck the grain out of the pipe as it is pushed down.

For any additional information connected with cooling stored grain or for further details on how to build air ducts, see your farm adviser or write to the Department of Agricultural Engineering, College of Agriculture, University of Illinois, Urbana.
Grain may spoil in storage, even if moisture is prevented from accumulating in the top layers. The major causes of spoilage are insects and high moisture — the grain is too wet when stored or moisture gets into the bin from the outside.

Grain insects contaminate grain intended for human use, besides eating about 2 percent of the nation’s farm-stored grain each month.

Too much moisture in the grain causes souring, heating, or molding, and promotes insect infestation as well. Grain can be dried to a safe moisture content by using heated or unheated air. And it can be kept dry if the bin is weathertight. Walls, roof, door, hatch openings, and cracks and knots in wooden bins or open bolt holes and loose bolts in metal bins all have to be made weathertight to keep out rain and snow.

These publications will help you to guard against grain insects and excessive moisture:

**GUARDING AGAINST INSECTS**
- How to Know and Control Stored-Grain Insects Circular 512
- Protect Your Stored Grain From Insects Circular 745

**DRYING STORED GRAIN**
- Drying Shelled Corn and Small Grain With Heated Air USDA Leaflet 331
- Drying Shelled Corn and Small Grain With Unheated Air USDA Leaflet 332

**KEEPING BINS WEATHERTIGHT**
- Storing Soybeans on the Farm Circular 692
- Grain Storage Building Plans Midwest Plan Service Circular

These circulars may be obtained without cost from your farm adviser or by writing to the College of Agriculture, University of Illinois, Urbana.