Drying the Crop with Less Fuel

Cooperative Extension South Dakota State University
Drying the Crop with Less Fuel

Cooperative Extension Service
South Dakota State University, Brookings
U. S. Department of Agriculture
Drying the Crop with Less Fuel

By
William H. Peterson, agricultural engineer, Cooperative Extension Service, South Dakota State University, Brookings

If the crop is to be fed, high moisture storage should be seriously considered as a way to save fuel. Dry shelled corn or sorghum has the advantage that it can be either fed or marketed.

Fuel-Saving Suggestions for All Types of Drying

• Harvest at lower moisture content. It takes twice as much moisture removal to dry from 27% moisture to 15½% as from 22% to 15½% (See Table 1). There may be additional field loss at less than 24% moisture, but test weight (after drying) will be higher, and kernel damage will be less. This could mean a higher price per bushel.

• Don’t overdry. Corn that will not be kept over the following summer need not be dried to less than 15½%, if not damaged. It is not discounted in the market at 15½%. Overdrying represents wasted energy, and usually also means a loss to the owner of the corn if it is marketed. Overdrying down to 10% moisture means a loss of 7.2% of the pounds of “corn” that could have been sold (See Table 2).

SUGGESTIONS FOR BATCH-DRYING

High-Speed Batch or Continuous Flow

Reducing the amount of heat used in a typical batch-dryer where airflows of 100 cubic feet per minute (cfm) per bushel or more are used does not reduce the amount of fuel used per bushel, unless airflow is also greatly reduced. Because of likely problems with altering the intended operation of the dryer, it appears much more practical to seek some other ways to save fuel. Some of these are:

Table 1—Pounds of water removed per bushel in drying

<table>
<thead>
<tr>
<th>Initial Moisture Content (%)</th>
<th>Pounds water removed per bushel*</th>
<th>Pounds water removed per bushel, drying to 15½% moisture</th>
<th>Pounds water removed per bushel, drying to 13% moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>25.4</td>
<td>16.7</td>
<td>18.3</td>
</tr>
<tr>
<td>30</td>
<td>20.2</td>
<td>11.5</td>
<td>13.1</td>
</tr>
<tr>
<td>38</td>
<td>18.4</td>
<td>9.7</td>
<td>11.3</td>
</tr>
<tr>
<td>26</td>
<td>16.6</td>
<td>7.9</td>
<td>9.5</td>
</tr>
<tr>
<td>25</td>
<td>15.7</td>
<td>7.0</td>
<td>8.6</td>
</tr>
<tr>
<td>24</td>
<td>14.9</td>
<td>6.2</td>
<td>7.8</td>
</tr>
<tr>
<td>22</td>
<td>13.3</td>
<td>4.6</td>
<td>6.2</td>
</tr>
<tr>
<td>20</td>
<td>11.8</td>
<td>3.1</td>
<td>4.7</td>
</tr>
<tr>
<td>18</td>
<td>10.4</td>
<td>1.7</td>
<td>3.3</td>
</tr>
<tr>
<td>15½</td>
<td>8.68</td>
<td>0.0</td>
<td>1.6</td>
</tr>
<tr>
<td>13</td>
<td>7.1</td>
<td>--</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*Based on a “market bushel” of 56 pounds at 15½% moisture.

Table 2—Loss in value from overdrying shelled corn and grain sorghum

<table>
<thead>
<tr>
<th>Moisture content when sold, percent</th>
<th>Weight per bushel, pound*</th>
<th>“Shrinkage” loss, percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>15½</td>
<td>56.0</td>
<td>0.0</td>
</tr>
<tr>
<td>13</td>
<td>54.4</td>
<td>3.0</td>
</tr>
<tr>
<td>12</td>
<td>53.8</td>
<td>4.0</td>
</tr>
<tr>
<td>10</td>
<td>52.0</td>
<td>7.2</td>
</tr>
<tr>
<td>8</td>
<td>51.4</td>
<td>8.3</td>
</tr>
</tbody>
</table>

*Based on a “market bushel” of 56 pounds at 15½% moisture.

• Adjust burners for best efficiency; screen out trash for better airflow.

• Use Dryeration. Dryeration is a process in which corn is not cooled in the batch-dryer, but moved, warm, to a dryeration bin which will hold the amount of one day’s drying. Corn is dried to within 1½ to 2 points of moisture of the desired final moisture. Corn is left to “steam” in the dryeration bin during the day, and an aeration fan providing at least ½ cfm per bushel is turned on at night. Corn is cooled over night, moved to final storage in the morning. Cooling removes the final 1½ to 2 points of moisture (See Figure 1). Dryeration avoids tying up the batch dryer for cooling the corn, also reduces stress cracks and subsequent breakage of corn kernels in handling.

• Use bin-cooling. This operates the same as dryeration, except the final storage is aerated at ½ cfm per bushel, and corn is cooled by the bin aeration fan. This fan should be arranged to blow through the storage to avoid re-heating of the corn previously cooled.

• Partial drying plus bin cooling and aeration. Drying from 25% moisture to 18% moisture requires about half as much fuel as drying to 15½%. Shelled corn at 18% moisture can be stored over winter if kept at 40 degrees or less by aeration. For cooling ½ cfm per bushel is advised. After November 1, chances of having night-time air temperatures below 40 degrees are 80% to 90%.

See Figure 4 for allowable storage times, temperatures and moisture contents. Bin cooling and aeration down to 40 degrees will remove 1 or 2 points of moisture. Continuous operation of the fan whenever air temperature is above freezing will produce further drying in November and December; the final moisture content depends somewhat on the weather.

Standard aeration tunnels can be used for this; a recommended practice is to put completely dried corn in the corners of the bin where airflow is likely to be least before filling with partially-dried corn. (Be sure that surface area of perforated ducts is equal to at least one square foot for each 30 cubic feet per minute of airflow). For more information see Fact Sheet 532, “Cold-air Aeration for Temporary Storage of High Moisture Shelled Corn.”
**Batch-Drying in a Bin (See Figure 2)**

- Screen out trash for better airflow and safer storage.
- A bin-stirring device will increase airflow and drying rate by about 20% when drying in depths of 4 to 6 feet, less for shallower depths.
- Reduce drying air temperature. If corn is at 22% moisture instead of 27%, heat (as measured by temperature rise going through the heater) can be reduced in half, and drying rate will be about the same. The net saving in fuel should be about 50%. Efficiency is slightly better with less heat in above-freezing outdoor temperatures with the usual airflow of 10 cfm per bushel. Higher airflow will speed the drying rate, but will not improve the fuel efficiency. A second, identical fan on a batch-drying bin will increase airflow about 50%. For more information see Fact Sheet 530, "Batch-Drying in a Bin."

**In Storage Drying (See Figure 3)**

- Screen out trash and fine material for better airflow and safer storage.
- Use only enough heat to correct for humidity. Controlling the drying air at 55% relative humidity with a humidistat will dry corn to about 13% moisture. A constant temperature rise of 10 degrees will give about the same results. This procedure lets the natural heat in the air do more of the drying, avoids over-drying of the bottom layers, and saves fuel.
- Along with the above, load the bin more slowly, keep track of the drying front by probing from the top. Be sure you do not exceed the maximum recommended depth of undried crop as specified by the bin-dryer manufacturer. Usually this will be 5 to 7 feet for 25% moisture shelled corn in bins 15 feet deep. Most drying bins can be filled with 20% moisture corn in one day using the above amount of heat. Check the manufacturer’s recommendations. Remember that if you keep the wet corn cooler, you have longer to get it dry, and drying will take less fuel. Corn cooled 20 degrees will keep four times as long, but only take twice as long to dry at the same relative humidity (See Figure 4). It is generally cheaper to move the extra air than to burn extra fuel if temperatures are above freezing. If corn temperature is 50 degrees you have 30 days to dry un-
damaged, 22% moisture shelled corn before dry-matter loss exceeds one-half percent. For more information see SDSU Cooperative Extension Service Fact Sheet 531, "In-Storage Drying."

**Low-Temperature Electric-Heat Drying**

This is a relatively new practice, but many successful systems are in use. The process depends on the use of lower temperatures (50 degrees to 30 degrees) and a small amount of heat (approximately 7 degrees temperature rise) to correct the average relative humidity. Corn at 24% moisture, kept at 40 degrees, can take up to 40 days to dry (See Figure 4). This method is not recommended for corn that is over 26% moisture, or is damaged. For over 22% moisture, depth should usually be reduced (generally to around 10 feet for 25% moisture in a typical bin), because of the higher fan horsepower and pressure needed to secure 3 cfm per bushel in over 10-foot depths.

Some procedures that must be strictly adhered to are:

- The following amount of air:
  - 26% moisture—3 cfm per bushel
  - 24% moisture—2 cfm per bushel
  - 22% moisture—1½ cfm per bushel

(A typical drying bin, such as one 24 feet in diameter and 15 feet deep, with 7½ hp fan, provides about 1½ cfm per bushel when filled. Static pressure will be about 3½ inches. Maximum moisture content would be 22% for a full bin. Such a bin could be filled to about a 10-foot depth with 25% moisture corn, then filling completed when corn in the bin and in the field is down to 22% moisture.)

- Don’t try it on damaged corn; damage accelerates spoilage.
- Screen out trash and fines. Use a distributor in the bin.
- Operate the unit continuously except during prolonged below-freezing temperatures.
- Operate the heater continuously except when over 50 degrees outside.
- Interlock fan and heater so heater cannot operate unless fan is running.
- Locate the fan so that noise will not be a bothersome factor.
- Don’t start harvesting and storing until temperatures average 50 degrees or less (around October 15 in central South Dakota).

For more information see "Low-temperature Drying of Shelled Corn," Illinois Farm Electrification Council.

**Cold-Air Aeration**

Shelled corn can be held in "cold storage" for drying or feeding, either in a bin or in a pile on the ground with an aeration system operated during night-time hours. The number of days corn can be stored at different temperatures and moisture contents is shown in Figure 4.
Night-time temperatures in South Dakota have an 80% to 90% chance of being down to 40 degrees after November 1. Corn should be undamaged, and moisture content at 22% moisture or less for this practice to get reasonably long storage times.

Recommended airflow is 3 cfm per bushel. After the corn is cooled, the fan should be operated twice a week, regardless of cold outside temperatures, to be sure there is no heating taking place in the corn. For more information see SDSU Cooperative Extension Service Fact Sheet 532, "Cold-air Aeration for Temporary Storage of High-moisture Shelled Corn."

Natural-Air Drying—Ear Corn

Ear corn is easily dried with unheated air, and can be harvested without damage up to 35% moisture. Ears

Figure 5—Single crib partially enclosed with canvas or reinforced paper. Air dust of canvas outside the crib. (From: Leaflet 334, Drying Ear Corn with Unheated Air, USDA.)

Natural-Air Drying, Shelled Corn and Sorghum

Because of the higher airflows required, and the higher fan horsepower needed to produce them, natural-air drying of shelled corn and sorghum is limited to depths of about 8 to 10 feet. This can be accomplished in flat storages (See Figure 7). However, the addition of a small amount of heat will make the operation more reliable and lower airflow requirements considerably. (See the section on low-temperature electric-heat drying.) Recommended airflows for natural-air drying of shelled corn and sorghum are:

ACCU-DRI®

DUCT HEIGHT (H) SHOULD BE AT LEAST 1/3 OF CRIB WIDTH (W)
25% moisture—5 cfm per bushel
20% moisture—3 cfm per bushel
18% moisture—2 cfm per bushel

For more information see USDA Farmer's Bulletin No. 2214, “Drying Shelled Corn and Small Grains.”

Solar Heat for Drying

Solar heat can be collected to heat air used for crop drying with a relatively simple device. What is needed is an insulated black surface, with a transparent material suspended above it, and air circulated between the two. Any south-facing wall or roof can be used. Collectors can be laid on the ground. Solar energy amounts to about 900 watts per square yard, and a relatively simple collector will capture and put into the airstream about 70% of the energy striking it.

One type of solar-heat bin design is illustrated in Figure 8. For more information contact the author of this publication.

Figure 6—An inexpensive, easily built crib for the mechanical drying of ear corn. (From: Leaflet 334, Drying Ear Corn with Unheated Air, USDA.)

Figure 7—A flat storage with a central duct in combination with a false floor. (From: Farmers’ Bulletin 2214, Drying Shelled Corn and Small Grains, USDA.)

WOOD PLATFORM ON TREATED WOOD SILLS.
LAY BUILDING PAPER TO MAKE FLOOR AIRTIGHT
Recommendations for Sorghum

The air flow requirements and drying principles mentioned for drying corn also apply to sorghum. Sorghum requires about 2.5 times as much pressure to produce a given airflow through it as does shelled corn. Sorghum is usually harvested at lower moisture content than corn, so less airflow is required, and fan horsepower is about the same.

When selecting fans for drying sorghum, look at fan air-delivery tables to select fans that deliver the most air at static pressures of 4 to 6 inches.

Not as much is known about the allowable storage times for sorghum at different temperatures and moisture contents as for shelled corn. Results should be similar at moisture contents of 18% or less if the crop is undamaged, but definite recommendations on cold air aeration cannot be made at this time.

Other Fact Sheets in This Series

This Fact Sheet is one of six in a series dealing with fuel-energy requirements in harvesting and storage of corn and grain sorghum. The entire series includes the following:

FS 605—Corn Harvesting Alternatives and Associated Fuel-Energy Requirements.
FS 606—Grain Sorghum Harvesting Alternatives and Associated Fuel-Energy Requirements.
FS 607—Drying the Crop with Less Fuel.
FS 608—Efficient Corn and Sorghum Harvesting.
FS 609—High Moisture Grain Storage
FS 610—Temporary Storage.

These fact sheets are available through your county Extension agent or the Bulletin Room, South Dakota State University, Brookings, S. D. 57006.