Grain Storage Problems

• Mold
  – Moisture
  – Temperature

• Insects
  – Temperature
  – Cleanliness
  – Grain Protectant
    • Long-term storage
Grain Storage Steps

- Prepare the structure.
- Prepare the grain.
- Manage the stored grain:
  - Monitoring
  - Aeration
Clean the Structure
Prepare the Grain

- Grain moisture
- Grain temperature
- Grain condition-kernel damage
Moisture Measurement

Representative Sample

Follow Instructions

- Adjust for temperature
- May not be accurate <40°F
- Electronic meters more sensitive to outside of kernel
- Meters affected by condensation

- Measure moisture content
- Place sample in sealed container for 6-12 hrs.
- Warm to ~70°F
- Recheck moisture
Equilibrium Moisture Content

HRS Wheat

EMC = 13.3%

Air

70°F
60% RH

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## Recommended Long-Term Storage Moisture Content

**EMC @ 70°F & 60% RH**

<table>
<thead>
<tr>
<th>Grain</th>
<th>EMC</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>11.8%</td>
<td>12%</td>
</tr>
<tr>
<td>Canola</td>
<td>8.0%</td>
<td>8%</td>
</tr>
<tr>
<td>Corn</td>
<td>12.8%</td>
<td>13%</td>
</tr>
<tr>
<td>Flaxseed</td>
<td>8.3%</td>
<td>8%</td>
</tr>
<tr>
<td>Soybeans</td>
<td>10.2%</td>
<td>11%</td>
</tr>
<tr>
<td>Sunflower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Oil</td>
<td>9.6%</td>
<td>10%</td>
</tr>
<tr>
<td>Oil</td>
<td>7.4%</td>
<td>8%</td>
</tr>
<tr>
<td>Wheat</td>
<td>13.3%</td>
<td>13.5%</td>
</tr>
</tbody>
</table>
## “Approximate” Allowable Storage Time for Cereal Grains (Days)

<table>
<thead>
<tr>
<th>Moisture</th>
<th>30°</th>
<th>40°</th>
<th>50°</th>
<th>60°</th>
<th>70°</th>
<th>80°</th>
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<tbody>
<tr>
<td>Content</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>200</td>
<td>140</td>
</tr>
<tr>
<td>(%)</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>240</td>
<td>125</td>
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<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>230</td>
<td>120</td>
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<tr>
<td>15</td>
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<td>130</td>
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<td>200</td>
<td>90</td>
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<tr>
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<td>140</td>
<td>70</td>
<td>35</td>
<td>20</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90</td>
<td>50</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>25</td>
</tr>
<tr>
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<td>15</td>
<td>8</td>
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<tr>
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<td>60</td>
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<td>15</td>
<td>8</td>
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<td>40</td>
<td>15</td>
<td>10</td>
<td>6</td>
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<tr>
<td>24</td>
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<td>12</td>
<td>8</td>
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<td>25</td>
<td>70</td>
<td>30</td>
<td>10</td>
<td>7</td>
<td>4</td>
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<td>26</td>
<td>60</td>
<td>25</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

* Exceeds 300 days
**“Estimated” Allowable Storage Time for Malting Barley (Weeks)**
(Criterion: Germinability)

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>11%</th>
<th>12%</th>
<th>13%</th>
<th>14%</th>
<th>15%</th>
<th>16%</th>
<th>17%</th>
<th>18%</th>
<th>19%</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>32</td>
<td>25</td>
<td>16</td>
<td><strong>10</strong></td>
<td>5</td>
<td>3</td>
<td>1.5</td>
<td>1</td>
<td>1</td>
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<tr>
<td>21</td>
<td>80</td>
<td>60</td>
<td>38</td>
<td>25</td>
<td>14</td>
<td>7</td>
<td>3.5</td>
<td>2.5</td>
<td>2</td>
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<tr>
<td>16</td>
<td>*</td>
<td>*</td>
<td>94</td>
<td>61</td>
<td>37</td>
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<td>9</td>
<td>6</td>
<td>3.5</td>
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<tr>
<td>10</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>90</td>
<td>50</td>
<td>20</td>
<td>14</td>
<td>8</td>
</tr>
</tbody>
</table>

* Allowable storage time exceeds 100 weeks.

Source: Drying Cereal Grains by Brooker, Bakker-Arkema & Hall
Table developed by Kenneth Hellevang, Ph.D., P.E., 07/16/07
Clean Grain before Storing
Fall and Winter Moisture Migration
Grain Stays Warm without Aeration
Spring and Summer Moisture Migration
Cool Grain to Prevent Storage Problems

- Optimum for Insects and Spoilage
- Insect Reproduction Reduced
- Insects Dormant
- Insects Killed

* Prevent crusting due to moisture migration by cooling grain to within 15°F of average outdoor temperatures.
* Cooling grain by 10°F doubles its allowable storage time

Dr. Kenneth J. Hellevang, Ph.D.
NDSU Extension Service
Aeration Used to Control Grain Temperature
Preferred Duct Spacing

Drying

Aeration

\[
\text{Depth of grain} \quad \frac{1}{4} \text{ Depth} \quad \frac{1}{2} \text{ Depth} \quad \text{Drying Front} \quad \text{Duct}
\]

\[
\text{Grain Depth} \quad \frac{1}{2} \text{ Depth}
\]
Fronts Using Air Ducts

Airflow is not uniform!
Both between and along ducts.
Level Bins
Aeration Cycle Time

Cooling Time (Barley)

\[
\frac{15}{\text{cfm/bu}} \times \frac{\text{Test Weight}}{56} = \text{hrs}
\]

\[15 / 0.2 \text{ cfm/bu} \times 48 /56 = 65 \text{ hrs}\]

Barley - 42 ft diameter, 24 ft depth
3.0 hp, 18-inch axial fan, 0.19 cfm/bu
Cooling time = 68 hrs.
Aeration Investment

42 ft diameter, 26 ft deep, 28,800 bu Barley level full
At 0.17 cfm/bu       Cooling time = 76 hrs/cycle
3.0 hp 18-inch Axial Fan, 3 hp fan uses 3.45 kWh/hr
12 cycles x 76 hrs = 912 hrs total/yr
3.45 kWh/hr x 912 hrs = 3,164 kWh
3,164 x $0.10 kwh = $314.64
$314.64 / 28,800 bu = $0.011/bu

≤1¢/bu – yr for insect and mold protection
Fans Off During Snow/Rain/Fog
Cover Fans When Not Operating

- Prevents spring warm-up
- Keep snow & pests out
- Keep damp air out

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WARNING

Condensation may freeze over vents when outside air temperatures are near or below freezing.

Leave fill and access open. Iced over vents will damage bin.
Management

Monitor:

• Temperature
• Moisture
• Insects

How often should I check my grain?

• 2-weeks until cooled
• 2-4 weeks during winter
• 2-weeks spring & summer
Senses only grain near cable
Grain Temperature

Average Maximum Air Temp.
February 1 - 15°
March 1 - 27°
April 1 - 45°
May 1 - 65°

Solar Radiation (Btu/ft²-day)

<table>
<thead>
<tr>
<th></th>
<th>Wall</th>
<th>Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb. 21</td>
<td>1725</td>
<td>1800</td>
</tr>
<tr>
<td>Jun. 21</td>
<td>800</td>
<td>2425</td>
</tr>
</tbody>
</table>

Periodically Cool
Ventilate Bin Headspace
Spring & Summer Cooling

Cooling Time

\[
15 / 0.2 \text{ cfm/bu} = 75 \text{ hrs}
\]

\[
3/20 = 0.15 \approx 11 \text{ hrs}
\]

Coolest at sunrise
Grain Hazards

Bridging transfers load to the bin wall

CAUGHT IN THE GRAIN!
AE-1102

Ice on blade may cause it to disintegrate

Moldy Grain Health Hazard
For More Information

Internet Search: NDSU Grain Drying & Storage