PROACTIVE STORED GRAIN MANAGEMENT

Klein Ileleji, PhD.
Professor & Extension Engineer
Agricultural and Biological Engineering

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Beck Agricultural Center
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Presentation Outline

• Working through harvest and storage
• Grain drying systems review
• Drying frost-damaged corn and soybeans
• Proactive stored grain management
• What should I do (WSID)?
2019 Harvest Update

• US corn harvest is 89% complete and soybean is 96% complete.
• Indiana corn is 93% complete; last year was 99% and 5-year average is 98%
• Indiana soybean is 96% complete; last year was 98% and 5-year average is 99%


Some Challenges This Year

• Wetter corn and soybean than average
• Corn with less test weight
• Immature and frost damaged beans
• Dryer couldn’t keep up with wet grain
• Lack of fuel (propane and NG) to dry
• Late harvest and colder temperatures resulting in more energy needed to warm cold air for drying.
Prepare for Late Season Harvest

- **Prepare drying equipment early.**
  - Contact service technician
  - Clean out equipment
  - Purchase enough fuel
- **Plan to harvest early and dry**, rather than leave on the field to dry-down. Don’t count on the weather.
- **Handle trash.** Crop will most likely have more trash than normal, so plan to clean out dryer frequently during operation.
- **Dry sufficiently to a safe moisture content** depending on marketing plans.
- **Cool down adequately after drying** to prevent early on-set of heating and subsequent spoilage.

Some important things to note about stored grain management

- Because seasonal patterns of weather could change, it’s best to be conservative on moisture. Storing lower moisture grain is better than storing grain on the margins of safe moisture.
- Invest in monitoring technologies and understand what your data means.
- Check your stored grain frequently, especially when it gets warm.
- Should you smell deteriorating grain around your storage bins, investigate to determine active spoilage. Remove spoiled grain from the bin if possible. Turn on aeration fans to slow down spoilage.
- Practice safe bin entry procedures. #1. Never work alone in a bin.
How much should I dry my grain?

Source: MWPS 13, Grain Drying, Storage and Handling Handbook, Third Edition

<table>
<thead>
<tr>
<th>Grain Type</th>
<th>At Harvest</th>
<th>Up to 6 months</th>
<th>6-12 months</th>
<th>&gt; 1 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelled corn &amp; sorghum</td>
<td>30</td>
<td>15</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Soybeans</td>
<td>18</td>
<td>13</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Wheat, barley oats</td>
<td>20</td>
<td>14</td>
<td>13</td>
<td>12</td>
</tr>
</tbody>
</table>

Grain Moisture Indicator Issues

Check your moisture meter calibration with your grain elevator

- Check calibrations of your field moisture meters with calibrated elevator moisture meters
- Warm up cold grain or cool-down hot grain to room temperature before taking moisture reading.
- If bias occurs in instrument, fix as per manufacturers instructions

Perten AM 5200

Dickey-john GAC-2500
Impact of aeration on grain spoilage (24.6 -> 12.6%)

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What happens during the grain drying process?

- **Inlet air (1)** = air at ambient conditions
- **Heating (2)** = air passes across burner/heater and temperature increases
- **Drying (3)** = air passes through grain mass, exchanges heat and moisture with grain
- **Exhaust air (4)** = air leaves drying chamber at lower temperature and higher absolute humidity
Drying System Categories

- **Low Temperature**
  - Natural air or air heated by up to 5-15°F (+3-8°C)
  - In-bin (or in-storage)

- **Medium Temperature**
  - Kernel temps **below 110°F** (43°C) for seed and food grains, and **below 140°F** (60°C) for all others (incl. #2 yellow corn, waxy, HOC)
  - In-bin or column

- **High Temperature**
  - Kernel temps above 140°F (60°C)
  - In-bin or column

- **Combination**
  - Med temp plus dryeration or in-bin cooling
  - Med-low temp 2-stage drying

Factors Influencing Drying Capacity

- Drying air temperature
- Airflow rate
- Ambient conditions
- Grain variety characteristics
- Final and initial moisture content
- Moisture variability in batch
- Levels of trash/foreign material
- Cooling location (in-dryer or in-bin)
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What are you drying?

- Commodity grain
- Food grade grain
- Seed
- Rice

These all have limits based on grain temperature or moisture content removal that impacts end use quality.

### Grain Type – End Use – Maximum Kernel Temperature

<table>
<thead>
<tr>
<th>Grains</th>
<th>End Use</th>
<th>Temperature (°F)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORN</td>
<td>Dry Milling &amp; Seed</td>
<td>100-110° F</td>
<td>38-43° C</td>
</tr>
<tr>
<td></td>
<td>Wet Milling</td>
<td>130-140° F</td>
<td>54-60° C</td>
</tr>
<tr>
<td></td>
<td>Feed Use</td>
<td>160-180° F</td>
<td>71-82° C</td>
</tr>
<tr>
<td>WHEAT</td>
<td>Seed (&gt; 24%)</td>
<td>110° F</td>
<td>43° C</td>
</tr>
<tr>
<td></td>
<td>Seed (&lt; 24%)</td>
<td>120° F</td>
<td>49° C</td>
</tr>
<tr>
<td></td>
<td>Flour</td>
<td>120-170° F</td>
<td>49-77° C</td>
</tr>
<tr>
<td>SOYBEANS</td>
<td>Seed</td>
<td>100° F</td>
<td>38° C</td>
</tr>
<tr>
<td></td>
<td>Oil Crushing</td>
<td>120° F</td>
<td>49° C</td>
</tr>
<tr>
<td>SUNFLOWER</td>
<td>Food</td>
<td>140-170° F</td>
<td>60-77° C</td>
</tr>
<tr>
<td></td>
<td>Oil Crushing</td>
<td>170-195° F</td>
<td>77-91° C</td>
</tr>
<tr>
<td>RICE</td>
<td>Milling (&gt;20%)</td>
<td>105° F</td>
<td>41° C</td>
</tr>
<tr>
<td></td>
<td>Milling (&lt;20%)</td>
<td>110° F</td>
<td>43° C</td>
</tr>
<tr>
<td>BARLEY</td>
<td>Malting</td>
<td>105-120° F</td>
<td>41-49° C</td>
</tr>
<tr>
<td></td>
<td>Feed</td>
<td>165-185° F</td>
<td>74-85° C</td>
</tr>
<tr>
<td>EDIBLE BEANS</td>
<td>Food Use</td>
<td>100° F</td>
<td>38° C</td>
</tr>
</tbody>
</table>
Drying Frost-Damaged Corn and Soybeans

- Frost damage is a possibility for late harvest corn and soybeans
- Options on harvesting, drying and storage of frost-damaged corn and soybeans depends on developmental stage.
- Frost damage will impact crop as follows:
  - Reduced yields
  - Increased dockage due to lower test weight or undesirable color
  - Reduced harvest efficiency
  - Wetter grain than normal
  - Increased drying cost

How to dry frost-damaged corn

- Expect slower field moisture dry-down rates late in the fall
- Keep air temperatures below 120-140°F range using medium and low temperature drying systems
- Keep air temperatures below 140-160°F in column dryers
- Grain can be transferred hot and cooled in a bin or dried and cooled in a column dryer
- Dry corn to 14% or below and plan for short storage period
- Because of reduced drying capacities, corn may be in wet holding bins longer, Watch out to make sure blue-eye mold doesn’t develop.
- Preferably screen corn to remove fines and core center during binning to ensure good airflow at the center
How to dry frost-damaged soybean

- Late fall harvest, wet and cool conditions may result harvest in soybeans at 16-20% moisture.
- Note that too much heat while drying soybeans causes excessive seed coat cracking.
- The key factor to avoid seed splits is to keep the relative humidity (RH) of the drying air above 40%; this limits heat input and drying capacity.
- For example, 50°F outside air temperature at 80% RH can only be heated to 70°F in order to maintain humidity above 40%.
- If using column or bin dryers, restrict heat input by using short heat-on cycles or changing the burner jets to fire low. Reduce temperature rise of air by reducing the total burner firing ON/OFF cycle (no more than half an hour exposure at a time).
- If splits are not of concern, limit drying air temperatures to 120-140°F.
- It’s better to dry frost damaged soybeans to 11-12%

Basic Concepts of Stored Grain Management

- Grain is a biologically active material and therefore it will deteriorate in storage under favorable conditions.
- Stored grain quality cannot be improved but maintained.
- Therefore, knowing the history and initial grain quality is an important first step in managing grain in storage.

**Grain Quality after Storage = F(Quality_{T_o}, Mgt, ?)**

How can we accurately predict this?
Your Investment in Storage

Maintaining Quality is Job #1 in Stored Grain Management

The Stored Grain Ecosystem

- Temperature
- Grain moisture & RH
- Gases: CO₂ & O₂
- Solar radiation, precipitation, etc.
- Other plant materials
- Insects, mites, rodents, birds
- Contaminants: frass, faeces, etc.
- Mold & Mycotoxins
- Phy., chem. & biol. controls
Storage Life of Grain

The concept of SLAM for stored grain systems was developed in the 1990s by Purdue University Extension Engineer and Specialists: Dr. Dirk Maier (Agricultural Engineer), Dr. Linda Mason (Stored-Product Entomologist) and Dr. Charles Woloshuk (Stored-Product Pathologist).

Acknowledgements:
Thanks to Dr. Linda Mason, Purdue Entomology Department and Dr. Dirk Maier, Department Head at Kansas State University Grain Science Program and Mr. Dave Crompton, Integris USA, LLC. for providing the contents of this presentation.

Source: http://www.extension.iastate.edu/CropNews/2009/1015hurburghelmore.htm

| Corn temperature °F | Moisture Content Corn (top %), Soybean (bottom %) | | |
|---------------------|---------------------------------|---|---|---|---|---|---|
|                     | 13%, 14%, 15%, 16%, 17%, 18%, 24% | N/A | 11% | 12% | 13% | 14% | 15% |
| 40                  | 150, 61 | 29.0 | 15.0 | 9.4 | 6.1 | 1.3 |
| 50                  | 84, 34 | 16.0 | 8.9 | 5.3 | 3.4 | 0.5 |
| 60                  | 47, 19 | 9.2  | 5.0 | 3.0 | 1.9 | 0.3 |
| 70                  | 26, 11 | 5.2  | 2.8 | 1.7 | 1.1 | 0.2 |
| 80                  | 15, 6  | 2.9  | 1.6 | 0.9 | 0.9 | 0.06 |

*Based on 0.5% maximum dry matter loss—calculated on the basis of USDA research at Iowa State University. Corresponds to one grade number loss; 2-3% points in damaged seeds. Soybean approximated at 2% lower moisture than corn.
Sanitation
Think Insect Clean!

Pest Prevention

Empty Bin Treatment

External Spray

Internal Spray
Loading

Eliminate the potential for loading by:
• Cleaning grain to remove fines and foreign material
• Drying grain gently by using appropriate drying techniques to prevent stress cracks
• Handling gently using appropriate grain conveying devices

Pre-Cleaning
Cushion Boxes and Flow Retarders

Bin Entrapment Rescue in Spring 2005

What do you think was the cause of this event?
Advisable to create core in stored grain, which facilitates airflow and makes aeration more efficient.
Aerate – to slow down bio-activity

Move *Aeration Front* through grain mass as quickly as possible!

Airflow of 1 cfm/bu is advisable
Cooling grain by aeration

Temperature Influence on Insects

Fields, 1992

<table>
<thead>
<tr>
<th>Temperature (°F)</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>122+</td>
<td>Death in minutes</td>
</tr>
<tr>
<td>95+</td>
<td>Development stops</td>
</tr>
<tr>
<td>77-90</td>
<td>Optimum</td>
</tr>
<tr>
<td>66-77</td>
<td>Sub-optimum</td>
</tr>
<tr>
<td>41-60</td>
<td>Death in days</td>
</tr>
<tr>
<td>0</td>
<td>Death in minutes</td>
</tr>
</tbody>
</table>

Source: Dr. Kenneth Hellevang, North Dakota State University
Aeration Phases

• Phase 1: Fall Cool Down
  — Lower grain temperatures stepwise
    • October – 40-45°F
    • November – 35-40°F
    • December – 28-35°F

• Phase 2: Winter Maintenance
  — Maintain low temperatures with intermittent aeration:
    January, February- 28-35°F

• Phase 3: Spring Holding
  — Keep grain cold from winter aeration
    • Seal fans
    • Ventilate only headspace intermittently

Source: Dr. Dirk Maier, Kansas State University

No Summer Aeration to warm-up grain!
Monitoring:

You can’t manage what you don’t know is there
Monitor temperature with temperature cables

It takes a while to detect deterioration and hot spots using temperature cables alone

CO₂ Monitors – Early Spoilage Detection
The Andersons, Delphi - Tank 54 (Semi-wet 17.5% MC)

Total CO2 (kg)

- 53.7 kg (May 28)
- 178.2 kg (June 09)
- 283.5 kg (June 24)

Early Detection!

April 17

April 24

283.5 kg (June 24)

178.2 kg (June 09)

53.7 kg (May 28)

Post-Harvest Management

- Monitor stored grain bin throughout the storage season.
- Increase frequency of monitoring if warm spell passes through.
- Once grain has been cooled to below 30°F in the winter, aerate grain bulk only when grain is suspect to be undergoing deterioration.
- Don’t warm up grain in the spring after winter aeration.
What Should I Do (WSID)?

• I discover that grain at the surface has begun to sprout.
• I find a load of severely out of condition grain; load in the bin with good grain and aerate?
• Of 200,000 bu corn, I have 150,000 bu dried to 15% and the rest 50,000 bu still wet at 20%.
• I’m alone unloading my bin and the auger stops because of a potential blockage.


This handbook was developed to assist farmers, elevator managers, equipment dealers, students, and others interested in developing grain systems.  
The price for this new edition is $74 + shipping.  
Save 10% if you place an order on-line by July 26, 2017.  
https://www.mwps.sws.iastate.edu/catalog/grain-handling-storage/grain-drying-handling-and-storage-handbook
Resources

Some Extension websites from U.S. Land-Grant Universities:

- http://extension.entm.purdue.edu/grainlab/
- http://www.extension.iastate.edu/Grain/
- http://www.oardc.ohio-state.edu/nc213/
- http://uarpp.uark.edu/personnel.htm
- http://entoplp.okstate.edu/sprec/index.htm

Thank You!
Questions?
Klein E. Ileleji, Ph.D.
Professor & Extension Engineer
Agricultural & Biological Engineering Department
Purdue University
225 S. University Street
West Lafayette, IN 47907-2093
Tel: 765-494-1198

Email: ileleji@purdue.edu
Grain Post-Harvest Extension:
http://www.grainquality.org