Stored Grain Management/Aeration

GEAPS Stored Grain Management Workshop
Angola, IN
03.26.15

Presented by:
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Safe-Grain, Inc./ Maxi-Tronic, Inc.
GRAIN VALUES TODAY = SERIOUS COIN

Typical 50,000 bushel bin

500,000 Bu. Corn @ $4.00 = $2,000,000.00
500,000 Bu. Beans @ $10.00 = $5,000,000.00
500,000 Bu. Wheat @ $6.00 = $3,000,000.00
ALCHEMY

Is grain aeration an art or a science?

Alchemy was the science of turning a base element into gold. Grain aeration has been described as a similar science.

Many operators may feel that their merchandisers buy poor quality grain and expect the superintendent to turn the junk into “gold”.
STORAGE MANAGEMENT

Grandpa factor- this is how we have always done it.....
PROCEDURES

INVENTORY CONTROL
(GRAIN QUALITY & QUANTITY)

GRAIN RECEIVING / TESTING

INBOUND INSPECTION PROCEDURE
MOISTURE METERS CHECKED
KNOWN GRADING AND PHYSICAL FACTORS RECORDED
STORAGE MOISTURE LEVELS
PROCEDURES

WEIGHING / QUANTITY
CHECK SCALE CALIBRATION

• SCALE SECURITY ITEMS
• ELEVATORS SCALES ARE SIGNIFICANTLY DIFFERENT THAN YOURS
• REGULAR BIN MEASUREMENT & DOCUMENTATION
• SECURE ALL GATES/ SIDE DRAWS ETC.
PROCEDURES

DRYING / WET GRAIN STORAGE

CALCULATING SHRINK

• DRYER CLEANED AT LEAST ONCE PER WEEK
• LENGTH WET GRAIN IS HELD
• SEGREGATING WET GRAIN
• DETERMINING GRAIN MOISTURE LEVEL
• PROCEDURES FOR DRYER FIRE OR SMOLDERING GRAIN
• WHO IS IN CHARGE OF ALL OF THESE ITEMS???
PROCEDURES

BINNING

- ARE BINS CLEANED & FUMIGATED PROPERLY?
- ARE THE BINS CORED AFTER FILLING?
- FACTORS DETERMINING BINNING DECISIONS?
- IS THERE AN INVENTORY METHOD?
- WHAT IS THE SCHEDULE FOR BIN EMPTYING, CLEANOUT, INSPECTION?
- WHO IS IN CHARGE OF ALL OF THESE ITEMS???
What is the main goal of storing grain?

Grain quality may be maintained but it will not be improved.

Grain can be segregated, cleaned, dried, aerated, fumigated, or transferred – but the incoming quality is as good as it will ever be.
ENEMIES OF GRAIN

- INSECTS
- MOLD & FUNGI
- MOISTURE
- HEAT
SHELF LIFE OF GRAIN

• Shelf life of the product is a function of product temperature and moisture

• Insects will cause more problems with grain temperatures above 56° F / 13° in products like wheat

• Mold likes moisture and mold is always a problem- especially with grain temperatures above 48° F / 9° in products like corn and soy beans
WHAT DOES GRAIN AERATION DO?

It changes the temperature of stored grain by using a fan to move outside air through the grain. Most of the time the grain will be cooled but there may also be occasions to raise the temperature of the grain. Thus the goal of aeration management is to “safely” change the temperature of the stored product to a temperature sufficient for safe storage.
AERATION EQUIPMENT DESIGN CRITERIA AND EQUIPMENT

What is it going to look like when you are done?

- Holding wet grain
- Cooling dry grain
- Long / short term storage management
- Warming dry grain in the spring or summer
SHELF LIFE OF GRAIN

The purpose of aeration is to maintain a consistent relationship between grain temperature and outside air temperatures that will minimize moisture migration and keep grain temperatures low to minimize deterioration rates.

Please keep in mind that quality can go to heck in a hurry!!!
**WHO WINS??**

Approximate Cooling Times to Raise or Lower Grain Temperature to Outside Air Temperature

<table>
<thead>
<tr>
<th>Rate</th>
<th>Summer</th>
<th>Fall</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 CFM/BU</td>
<td>16 Hours</td>
<td>24 Hours</td>
<td>32 Hours</td>
</tr>
<tr>
<td>1/5 CFM/BU</td>
<td>40</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>1/7 CFM/BU</td>
<td>56</td>
<td>84</td>
<td>112</td>
</tr>
<tr>
<td>1/10 CFM/BU</td>
<td>80</td>
<td>120</td>
<td>160</td>
</tr>
<tr>
<td>1/15 CFM/BU</td>
<td>120</td>
<td>180</td>
<td>240</td>
</tr>
<tr>
<td>1/20 CFM/BU</td>
<td>160</td>
<td>240</td>
<td>320</td>
</tr>
</tbody>
</table>

Will the fans “win” or will the mold and bugs “win”???
SELECTING AERATION MATERIAL

The main goal is to start with a well designed and balanced system.

Velocity and volume

Including roof vents.
SELECTING AERATION MATERIAL

Point of diminishing returns
Double the speed of a bucket elevator
– What happens?
Replace a 5,000 BPH leg with a 15,000 BPH leg and keep the old distributor and spouting sized for 5,000 BPH
- What happens?

Let’s double the fans on a bin-
Keep the venting, tunnel openings, perforated floor the same-
- What happens????
IMPORTANT STUFF

Air will always follow the path of least resistance

"A" is the shortest air path
"B" is a longer air path than "A"
"B" should be no longer than 1.5 times "A"
Air will always follow the path of least resistance.

"A" is the shortest air path. "B" and "C" are longer air paths than "A". "B" and "C" should be no longer than 1.5 times "A".
Air follows the path of least resistance—just like water, electricity,… And some employees
PUSH OR PULL?

Which is best?

The answer is that it depends on your needs and budget but the “POSITIVE OR PRESSURE (PUSH UP) WITH ROOF EXHAUST FAN” system offers the most flexibility to the operator.

<table>
<thead>
<tr>
<th>NEGATIVE (PULL DOWN) FANS AT GRADE</th>
<th>NEGATIVE (PULL UP) FANS ON ROOF</th>
<th>POSITIVE (PUSH UP) WITH ROOF EXHAUST FAN(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal for long term storage of dry grain</td>
<td>Can be used for both wet grain holding and dryeration</td>
<td>Normally used for short term storage of wet grain</td>
</tr>
<tr>
<td>Low cost</td>
<td>Lowest cost</td>
<td>Higher cost</td>
</tr>
<tr>
<td>Can be used on most types of storage</td>
<td>Cannot be used on most steel storage</td>
<td>Can be used on most types of storage</td>
</tr>
<tr>
<td>No moisture condensation under roof</td>
<td>Major moisture condensation under roof</td>
<td>Possibility of slight moisture condensation</td>
</tr>
<tr>
<td>Manifold dampers can be adjusted at grade</td>
<td>Manifold dampers can be adjusted at bin deck</td>
<td>Manifold dampers can be adjusted at grade</td>
</tr>
<tr>
<td>Moisture and fines will plug ducts</td>
<td>Moisture and fines normally do not plug ducts</td>
<td>Moisture and fines normally do not plug ducts</td>
</tr>
<tr>
<td>Fan noise at grade</td>
<td>Fan noise at roof/bin deck</td>
<td>Fan noise at grade only and roof</td>
</tr>
<tr>
<td>Little crusting on top of grain</td>
<td>Most crusting on top of grain</td>
<td>Best way to prevent crusting</td>
</tr>
<tr>
<td>Less conduit and wiring</td>
<td>More conduit and wiring</td>
<td>Most conduit and wiring</td>
</tr>
<tr>
<td>Air is pulled down through grain already in condition</td>
<td>Air is pulled up through grain already in condition</td>
<td>Air is pushed up through grain already in condition</td>
</tr>
<tr>
<td>Requires bin deck opening to allow air to enter bin (possible water leakage thru opening)</td>
<td>Requires bin bottom opening to allow air to enter bin</td>
<td>Requires air inlet at bin bottom and bin deck opening</td>
</tr>
<tr>
<td>Requires positive sealing of all roof openings from loading spouts and conveyors during aeration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This method offers the most flexibility.
NEGATIVE FANS AT GRADE

Lowest cost system

Works well with good, clean, dry grain
Negative Aeration No-No

Watch out when the outside temperature is right at freezing!!!
Frozen vents = Disaster
NEGATIVE- FANS ON ROOF

Lowest cost of all aeration systems.

Obviously – in this system it is very important to make sure that the fill spout is closed during aeration.
3 RULES

THREE SIMPLE RULES FOR SUCCESSFUL GRAIN STORAGE

RULE #1 KEEP STORED GRAIN AS UNIFORM AS POSSIBLE- TEMPERATURE, QUALITY, AND MOISTURE

RULE #2 TRY TO RUN FANS WHEN THE OUTSIDE AMBIENT TEMPERATURE IS WITHIN 15° F OF THE GRAIN TEMPERATURE

RULE #3 WHEN YOU START AN AERATION FRONT - FINISH THE AERATION FRONT
Typical Aeration Conditions

- Holding wet grain
- Cooling dry grain
- Long/short term storage maintenance
- Warming dry grain in the spring
CONденсATION

A temperature differential of 15° F is the magic number for condensation to occur.
HOLDING WET GRAIN

REMEMBER TO SIZE THE FAN, DUCT, AND ROOF VENTS TO THE JOB
POSITIVE AIR

• 1/5 or 0.20 CFM is recommended
• Some air is better than no air
• Avoid condensation with roof exhaust system fans
Roof vents in wet bins tend to plug faster than in dry grain storage bins.
COOLING DRY GRAIN

• Start fans as soon as the grain covers the aeration tunnel
• Cool to 35° to 40° F (2 to 4 ° C) as quickly as possible
• Run fans continuously until desired temperature is reached
• Turn the fans off when desired temperature is reached
Exhaust fans may be run without main fans on hot summer days to prevent condensation caused by temperature differentials of over 15° F between the ambient air temperature and the dead air space inside the silo.
EMC

SHELLED CORN FINAL KERNEL MOISTURE CONTENT
(Equilibrium Moisture Content - EMC)

% RELATIVE HUMIDITY

<table>
<thead>
<tr>
<th>AIR TEMP</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
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<tr>
<td>F</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20°</td>
<td>11.2</td>
<td>11.7</td>
<td>12.7</td>
<td>13.7</td>
<td>14.5</td>
<td>15.1</td>
<td>16.2</td>
<td>17.1</td>
<td>18.0</td>
<td>19.6</td>
<td>21.1</td>
<td>23.5</td>
<td>25.8</td>
</tr>
<tr>
<td>30°</td>
<td>10.8</td>
<td>11.3</td>
<td>12.2</td>
<td>13.1</td>
<td>13.9</td>
<td>14.6</td>
<td>15.5</td>
<td>16.4</td>
<td>17.4</td>
<td>18.7</td>
<td>20.2</td>
<td>22.5</td>
<td>25.0</td>
</tr>
<tr>
<td>40°</td>
<td>10.5</td>
<td>11.0</td>
<td>11.7</td>
<td>12.5</td>
<td>13.3</td>
<td>14.0</td>
<td>14.8</td>
<td>15.5</td>
<td>16.6</td>
<td>17.8</td>
<td>19.4</td>
<td>21.5</td>
<td>24.2</td>
</tr>
<tr>
<td>50°</td>
<td>10.1</td>
<td>10.6</td>
<td>11.3</td>
<td>12.0</td>
<td>12.7</td>
<td>13.3</td>
<td>14.1</td>
<td>14.8</td>
<td>15.8</td>
<td>16.9</td>
<td>18.6</td>
<td>20.5</td>
<td>23.4</td>
</tr>
<tr>
<td>60°</td>
<td>9.7</td>
<td>10.2</td>
<td>10.9</td>
<td>11.6</td>
<td>12.1</td>
<td>12.7</td>
<td>13.4</td>
<td>14.2</td>
<td>15.0</td>
<td>16.0</td>
<td>17.8</td>
<td>19.5</td>
<td>22.6</td>
</tr>
<tr>
<td>70°</td>
<td>9.0</td>
<td>9.7</td>
<td>10.4</td>
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<td>11.5</td>
<td>12.0</td>
<td>12.8</td>
<td>13.5</td>
<td>14.5</td>
<td>15.4</td>
<td>16.8</td>
<td>18.5</td>
<td>21.3</td>
</tr>
<tr>
<td>80°</td>
<td>8.3</td>
<td>9.1</td>
<td>9.8</td>
<td>10.5</td>
<td>10.8</td>
<td>11.2</td>
<td>12.1</td>
<td>13.0</td>
<td>13.9</td>
<td>14.8</td>
<td>15.8</td>
<td>17.4</td>
<td>20.0</td>
</tr>
</tbody>
</table>

This means that if the fans are run long enough at 40 F and 65% relative humidity air: the corn will eventually reach an EMC of 14.8%.
LONG / SHORT TERM WINTER STORAGE

- Monitor the grain temperature and if the grain temperature is stable the grain is stable and no further aeration is required or recommended.

- The cost of covering the positive fan inlets using inlet dampers can be justified.

- Negative fans should always have discharge dampers covering the fan opening as a matter of safety.
SPRING & SUMMER
LONG TERM STORAGE

• If the decision is made to warm up the grain from 35° F to 48° F +/- it should be done when expected fair weather periods provide sufficient fan operation time to warm the grain

• Warming the grain above 48° F / 9° C will increase potential mold growth opportunities and above 56° F /14 ° C will increase insect problems
EXHAUST FANS

Run exhaust fans 30-60 minutes after main fans are turned off
SMELL, LOOK, LISTEN, & TEST

Use your senses-

• Does the fan sound like it is struggling?

• What is the fan’s amp load as a % of full load amps?

• Is air going the wrong direction?
Giberrella in 2014

- Fungus lowers grain quality
- Grain may be downgraded for damaged kernels, reducing price/bu
- Maximum limits for damaged kernels are 5% for No. 2, 7% for No. 3 and 10% for No. 4 yellow corn.
- Grain storage life may be greatly reduced.
- Grain may be inferior or unsuitable for many feed and food uses and ethanol production if mycotoxins are produced.
INSECT AND MOLD CONTROL

- PERSON RESPONSIBLE FOR FUMIGATION
- LOCATION OF FUMIGATION PERMITS
- SILOS SPRAYED PRIOR TO FILLING
Safety - Roof vents with shutters and motors
Safety - Roof vents with shutters and motors
Note the roof access platforms
INSPECTING GRAIN IN BINS

• WEEKLY INSPECTION WITH RECORDS
• CHECK FOR INSECT / ANIMAL / BIRD EVIDENCE
• WHO IS RESPONSIBLE FOR INSPECTION?
• SAFETY PROCEDURES FOLLOWED AND DOCUMENTED
• LOOK FOR WATER LEAKS AT ROOF OR SIDEWALLS
• WHO IS RESPONSIBLE FOR THESE ITEMS???
FACILITY PROCEDURES

MISCELLANEOUS GRAIN STORAGE AND MATERIAL HANDLING PROCEDURES

- BLENDING PRACTICES
- ARE BINS CORED?
- CONDITION OF THE SCREENINGS
- RODENT, VERMIN, INSECT EVIDENCE
- PROPER MODIFICATION OF INVENTORY RECORDS
- THEFT PREVENTION PROCEDURES
- ADEQUATE & WORKING DUST CONTROL SYSTEM
- ADEQUATE & WORKING HAZARD MONITOR AND SAFETY SYSTEM
- WORKING & USED TEMPERATURE DETECTION SYSTEM
WHAT'S WRONG WITH THIS PICTURE?
THINGS TO LOOK FOR

Perfect world
A clean bin will improve your odds of successful grain storage
Over filling is bad too!!
VELOCITY PROBLEMS

RESTRICTED AIRFLOW!
RECIPE FOR DISASTER

EXTRA STORAGE SPACE
PERMANENT REPAIRS???

200 MPH
DUCT
TAPE
MOLD HEAVEN

GIVING MOLD A HEAD START ON THE THIS YEAR’S CROP
GRAIN TEMPERATURE DETECTION
GRAIN TEMPERATURE DETECTION

WHY TEMPERATURE DETECTION DETECTION

OVERVIEW

How do you measure grain quality inside of a bin/silo?

How can we look inside of the bin/silo?

The best, fastest, most reliable, and least expensive method is to know the grain temperature
Enemies of grain

IF THE TEMPERATURE OF THE GRAIN IS CHANGING
(LESS THAN A 3 DEGREE CHANGE CAN BE SIGNIFICANT)

WHY ??

• MOLD GROWTH
• MOISTURE MIGRATION
• HOT GRAIN DUMPED IN THE WRONG BIN
• INSECT INFESTATION
• HUMAN VARIABLES LIKE SOMEONE LEFT THE MAN HATCH OPEN
HOW DO TEMPERATURE CABLES ACTUALLY WORK???
TEMPERATURE DETECTION CABLES
10’ TO 12’ COVERAGE RANGE
GRAIN TEMPERATURE DETECTION

TEMPERATURE DETECTION CABLE SUSPENDED FROM ROOF BRACKET

NOTE CABLE TAG

ANOTHER REASON NOT TO OVERFILL
How do we obtain the temperature data from the temperature cables?

**PC based systems**

**Wireless or hardwired**

**Portable instrument systems**
GRAIN TEMPERATURE DETECTION

TEMPERATURE DETECTION SYSTEMS

ARE THE GRAIN TEMPERATURES READ & RECORDED DAILY/WEEKLY?

DO THE GRAIN TEMPERATURE DETECTION CABLES WORK PROPERLY?
MAIN SCREEN ON PC
GRAIN TEMPERATURE DETECTION

<table>
<thead>
<tr>
<th>Bin #1: NORTH #1 Commodity: Corn, Last reset on: 1/11/2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable #1</td>
</tr>
<tr>
<td>Cable #2</td>
</tr>
<tr>
<td>Cable #3</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

DETAILED REPORTS

LOOK FOR THE EXCEPTIONS
In conclusion, it is always the operator’s responsibility to monitor the quality of the grain.

- Moisture migration, mold activity, and insect infestation threaten the quality and condition of stored grain.
- It is up to the operator to monitor the temperature, the odor, and the visual appearance of the grain to interpret the condition of the grain.
- It is up to the operator to take prudent steps such as aeration, fumigation, and moving or turning the grain as required.
THINK SMART
More info???

www.safegrain.com

GENERAL CHECKLIST FOR INVENTORY CONTROL OF STORED GRAIN

www.geaps.com  DEPOC or “Distance Education Program”
THANK YOU GEAPS!