Grain Bin Monitoring and Automation

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ADVANTAGES OF MONITORING AND AUTOMATION

On-Farm Grain Storage

• Why store grain?
  – Adds flexibility to grain marketing program
  – Relief from harvest delivery pressure
  – Capture post-harvest market prices
• Large on-farm storage bins
  – Cheaper on a $/bu basis
  – But risky; it’s your bank account

Image: agriculture.com

Current State of Monitoring and Automation

• Implementation in 2009
  – Commercial: 90%
  – On-farm: 5%
• Key selling points
  – Reduce drying costs
  – Reduce risk of poor condition
  – Reduce shrink
  – Prevent spoilage
  – Reduce management labor


Advantages of remote monitoring capabilities

• Know what’s going on inside the bin
• Proactive management
• Reduce entry/climbing
• Remote grain checking

Image: CIP Integra
Image: grain-watch.com

“Risk Reduction”
“Value Retention”
Advantages of remote monitoring capabilities

- Know what’s going on inside the bin
- Proactive management
- Reduce entry/climbing
- Remote grain checking

“If we address quality, we can eliminate the need to enter a confined space where the grain is flowing... the only time we’re in a bin is when there’s a problem.”

Bob Marlow, The Andersons Inc.

Why enter a bin?
- Visual inspection
- Probing for quality
- Address caking, clumping, and bridging

Advantages of automated aeration control

- Moisture optimization and shrink reduction
- Energy savings and extended equipment life

Load 15% Store 13% Sell 15%

Value of Re-Hydration

- 967 bu Corn @ 13 %wb, 4 $/bu
  - Total = 54,234 lb
  - Moisture = 7,042 lb
  - Dry matter = 47,192 lb
  - Re-hydrate to 15 %wb
  - Dry matter = 47,124 lb
  - Moisture = (0.15 * 47,124 lb) / 0.85 = 8,316 lb
  - Total = 47,124 lb + 8,316 lb = 54,240 lb
  - Bushels sold = 990 bu

Value $3,960

Re-Gain 9.1 ¢/bu

Note: Rehydration energy can cost 5 ¢/pt/bu or more

Cost of shrinkage and handling

- 1,000 bu Corn @ 15 %wb, 4 $/bu
  - Total = 56 lb/bu * 1,000 bu = 56,000 lb
  - Moisture = 0.15 * 56,000 lb = 8,400 lb
  - Dry matter = 0.85 * 56,000 lb = 47,600 lb

- Dry down to 13 %wb
  - Handling loss = 47,600 lb * 0.01 = 476 lb
  - Dry matter = 47,600 lb – 476 lb = 47,124 lb
  - Moisture = (0.13 * 47,124 lb) / 0.87 = 7,042 lb
  - Total = 47,124 lb + 7,042 lb = 54,166 lb
  - Bushels remaining = 967 bu

Value $3,869

Loss 13.1 ¢/bu

Value $4,000

Email/Text Alarms

20 to 60% Reduction in Fan Run Time
20 to 60% Reduction in Energy Costs
2x to 5x Extension in Component Life
COMMERCIALLY AVAILABLE SYSTEMS

What are the commercial options?

- Monitoring
  - Grain temperature
  - Moisture content
  - Insect activity
  - Fan pressure
  - Inventory
- Communication
  - Alarms
  - Email/text
  - Web interface
- Logging
  - Historical trends
- Automation
  - Aeration control
  - Weather station

IntelliAir

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
<th>Price/bu</th>
<th>Temperature</th>
<th>Moisture</th>
<th>Logging</th>
<th>Inventory</th>
<th>Internet Access</th>
<th>Fan Automation</th>
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* Ballpark, based on 30,000 bu bin per Jan 2015 communication with Grain Specialist, Chance Hager

OPI

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* Ballpark, based on 30,000 bu bin per Jan 2015 communication with Grain Specialist, Dan Bruck

THE CLEMSON BIN AUTOMATION RESEARCH SYSTEM

- Monitor temperature
- Monitor moisture content
- Monitor grain inventory
- Monitor fan pressure
- Monitor fan pressure
- Monitor ambient temperature
- Monitor ambient humidity
- Monitor inspection hatch
- Monitor loading hatch
Grain Temperature and Moisture Sensing

**Equilibrium Moisture Content**

- Grain moisture content when exposed to:
  - Particular temperature
  - Particular relative humidity

Image: OPI Integris

**Automated Fan Control Logic**

- Cooling
  - If Grain Temperature > Setpoint
  - If Ambient Temperature < Grain Temperature

- Drying
  - If Grain Moisture > Setpoint
  - If Ambient Humidity < Grain Porespace Humidity

- Condensation Prevention
  - If Headspace Temp < Headspace Dewpoint Temp
Grain Moisture Content – One Week

Relative Humidity – One Week

Fan Pressure – One Week

Headspace CO₂ – One Week

Plans for the Clemson Bin Automation Research System

- Develop storage recommendations for milo
- Evaluate and demonstrate return on investment for bin automation
- Determine alarm points for CO₂
- Evaluate fan control logic
- Demonstrate advantages of monitoring and automation

Questions?
kirk2@clemson.edu
GRAIN STORAGE: USEFUL REFERENCES

Allowable Storage Time – Cereal Grains

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<tr>
<th>Moisture Content (%)</th>
<th>30°</th>
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* >300 days

Source: NDSU Extension

Effects of Temperature and Moisture on Stored Grain

Safe Moisture Storage for Grain and Seed

Insect Activity as a Function of Temperature

Source: OPI Integris
## Insects of Stored Grain – Resistance to Low Temperatures

<table>
<thead>
<tr>
<th>Insect</th>
<th>0°-5°F</th>
<th>5°-10°F</th>
<th>10°-15°F</th>
<th>15°-20°F</th>
<th>20°-25°F</th>
<th>25°-30°F</th>
<th>30°-35°F</th>
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<td>Saw-toothed grain hoatzia</td>
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<td>3</td>
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<td>1</td>
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<td>7</td>
<td>24</td>
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Source: Anderson and Atcock. 1954. Storage of Cereal Grains and Their Products