EMERGING TECHNOLOGIES ON STORED GRAIN MONITORING

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Presentation Outline

• Need for Grain Monitoring
• Current Grain Monitoring Approaches
• Emerging Grain Monitoring Technologies
Importance of monitoring

An average of 100,000 bu @ $3.68 per bu = $368,000

Maintaining Quality is Job # 1 in Stored Grain Management

Importance of monitoring

- 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(Ini.Quality, Mgt, ?)

How can we accurately predict this?
The Stored Grain Ecosystem

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

Molds glue kernels together when grain goes out of condition

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Hotspot caused by fine accumulation, insect and mold activity at the center of the bin

Poor grain management has been noted as a primary cause of grain entrapment
Importance of monitoring

- Anecdotal evidence suggests that less than 30% of grain bins on U.S. farms have some form of stored grain monitoring technology
- Indiana has been one of the leading states for grain entrapment. Indiana led the nation in 2016 and has recorded 162 entrapments since 1962 (Himler, 2017; Issa et al., 2013)
- With the increase in grain bin sizes for on-farm storage, farmers today are trying to use management principles that they successfully used to manage small grain stocks

Current Monitoring Approaches:

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.

**Real-time Insect Detection System**

As the insect breaks the Infrared beams, its size is registered. At the same time, the time and temperature is captured in the memory on the built-in microprocessor.

Available from: [www.opisystems.com](http://www.opisystems.com/)
Integris USA, LLC.
Insect monitoring - Pheromone flight trap

CO\textsubscript{2} Monitors – Early Spoilage Detection

CO\textsubscript{2} sensors has been demonstrated (Ileleji et al, 2006) as a reliable and quick method for detecting grain spoilage but effectiveness is weakened by the lack of rigorous data analytics and interpretation.
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## Comparative assessment of current monitoring technologies for stored grain

<table>
<thead>
<tr>
<th>Capability/Company</th>
<th>OPI-Integrity</th>
<th>Tri-state</th>
<th>CSI</th>
<th>TeleSense</th>
<th>Amber Ag</th>
<th>AgriDry LLC</th>
<th>Skyway</th>
<th>Grain Probe*</th>
</tr>
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<tbody>
<tr>
<td>Model</td>
<td>OPI Blue</td>
<td>GrainTrac</td>
<td>Grain Viz</td>
<td>Grainsafe</td>
<td>Bullseye</td>
<td>BinSense</td>
<td>GrainPatrol</td>
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### Current Monitoring Approaches:

Most of the current systems lack adequate and easy to use analytics based on fundamental understanding of stored grain ecosystems for informed decision making.
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### Emerging Technologies

- **Temperature logger**
- **Vents**
- **Temperature/RH Sensor**
- **Fan**
- **Air vent**
- **CO₂ sensors**
- **RH sensors**
- **Temperature sensors**
- **Conditioned Grains**
- **Plenum**
- **Aeration**

### Normal Moisture Grain (14.57%) in Sealed Bin

- **Bin opened and grain aerated**
- **Date/Time:** 7/3/19, 7/5/19, 7/7/19, 7/9/19, 7/11/19, 7/13/19, 7/15/19, 7/17/19, 7/19/19, 7/21/19
- **Temperature, °F:**
- **CO₂, ppm:**
  - **Top**
  - **Bottom**
- **Temp Top**
- **Temp Bottom**
- **Temp_Headspace**
- **Temp_Ambient**
Grain with hotspot (17.9→16.42%) in sealed bin

Grain at 14.57% mc
Post-Harvest Grain Quality

Grain with hotspot (18.86% mc)

Key Observations

- Monitoring both headspace and plenum CO₂ essential
- CO₂ peaked with daily rise of ambient and headspace temperature
- Although there was little daily variation of temperature within the grain, the followed the general trend of atmosphere and headspace
- Temperature within the grain does not reflect the variation of CO₂
CO₂ Monitoring at grain facility

CO₂ monitoring points

CO₂ sensors