Area-Wide IPM for Commercial Grain Storage

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Area-Wide IPM for Commercial Wheat Storage

- USDA-ARS Demonstration Project for Area-wide IPM for commercial stored grain in Kansas and Oklahoma.
- Two elevator networks, one in each state ≈ 844,000 tons (grown on ≈ 324,000 hectares).
- About 70% of the wheat that came to the 4 terminal elevators originated from country elevators participating in the project.
Application of the Area-wide IPM Concept to Stored Grain

- Area-wide IPM is particularly important for stored grain because insects are often moved through the marketing system along with the grain.
- Failure to control insects at country elevators early can provide a source of infestation that can infest much larger quantities of grain as it is combined and blended at the terminal elevator.
Insects of Stored Wheat

- **Rusty Grain Beetle:** *Cryptolestes ferrugineus*
- **Lesser Grain Borer:** *Rhyzopertha dominica*
- **Rice Weevil:** *Sitophilus oryzae*
- **Red Flour Beetle:** *Tribolium castaneum*
- **Sawtoothed Grain Beetle:** *Oryzaephilus surinamensis*
- **Parasitoid Wasps**
Insect Damage to Wheat

- Primarily from insects that develop inside the grain kernel: lesser grain borer and rice weevil
- Insect-damaged kernels or IDK can cause grain rejection
Why Not Use Moving Grain Samples?

- Moving grain samples were often difficult to acquire because of:
  - Grain blending from 2 or more bins
  - Unpredictable timing of grain movement

- Moving grain samples required turning grain, which is expensive - as long as you are turning, you might as well add the phosphine tablets.

- Turn and Treat: not exactly IPM - we needed a method to monitor insects without turning the grain, and to quickly get the information back to the manager.
Vacuum Probe: Best IPM Sampling Method

- Vacuum probe sampling provided the time needed to collect and process samples and then give the results to the elevator manager in time to take any needed action.
- Timing of sampling was less restrictive.
- Vacuum probe provided a vertical profile of insect density for each grain bin.
- Probe traps captured only surface insects.
- Bottom samples: poor correlation with average insect density in a bin.
Vacuum probe sampler was used to sample elevator grain bins (100-120-foot-tall)
A 3-kg sample was taken every 1.2m of grain, down to a depth of 12 meters.
A custom-designed inclined sieve is used to separate the insects from the grain. It allows us to rapidly separate insects from the 3-kg grain samples; so that we can leave the grain at the elevator and take only the fine material (which includes insects) back to the laboratory.
Insect Identification & Counting
Insect Species Found in Stored Wheat

- Lesser Grain Borer: 62.2%
- Rusty Grain Beetle: 22.8%
- Red Flour Beetle: 13.9%
- Sawtoothed Grain Beetle: 0.1%
- Rice Weevil: 1.0%
Seasonal Trends: Summer to Winter

Insects/Kg

Grain Depth (ft)

- Rusty Grain Beetle
- Lesser Grain Borer

**June**

**September**

17/kg

**November**

**February**
Seasonal Changes in Insect Density

Insects per kg of Wheat

Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May

0 1 2 3 4
Stored Grain Advisor Pro

- Developed by scientists at the USDA-ARS Grain Marketing and Production Research Center.
- Data from the vacuum-probe samples is entered into SGA Pro program.
- The program analyzes the insect data and recommends the best treatment strategy for each bin.
- SGA Pro also profiles the wheat protein for each bin so that elevators can optimize blending.
SGA Pro Decision Support Software

- SGA Pro’s management recommendations are aimed at commercial elevators
- Includes a database for: insect density, grain quality, bin characteristics, temperature and moisture
- Includes risk analysis for: insect density, moisture and temperature
- Includes a model that forecasts insect density based on current insect density, grain temperature and moisture
- Economic analysis
Adjustable Risk Rules

Risk analysis rules can be adjusted by the user for insect thresholds, hot spots, and grain moisture thresholds.
Bins in red are at high risk for damage
Bins in blue are at moderate risk for insect damage
Bins in green are safe from insect damage

Recommendation for bin 620
Fumigate, cool Aeration
This grain is at risk, fumigate now. Prevent population regrowth by aerating the grain to 60 F.
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Validation Methods

- SGA Pro was tested during the final two years of the area-wide IPM study.
- Bins at each elevator were sampled at approximately 6 week intervals, data were entered into SGA Pro, and the report recommendations were shown to the elevator managers.
- SGA Pro was validated by comparing predicted insect densities and control recommendations with actual insect densities in the same bins 6 weeks later.
- Validation data came from bins in which the grain had not been turned or fumigated for at least two sampling periods.
Validation Results

The number of correct predictions by Stored Grain Advisor Pro, and type A and B errors for elevator bins in Kansas and Oklahoma.

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<th></th>
<th>N</th>
<th>Correct</th>
<th>%</th>
<th>Type A&lt;sup&gt;1&lt;/sup&gt;</th>
<th>%</th>
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<td>26</td>
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<sup>1</sup>Type A errors: software predicts “safe” (< 2 insects per kg, and actual density in 6 weeks is > 2 insects/kg of wheat.  
<sup>2</sup>Type B errors: software predicts “medium risk” (> 10 insects per kg and actual density in 6 weeks is less than 10 insects/kg of wheat.
Value of the IPM Program

- Incidence of damaged kernels for year 1 of the scouting company were compared to samples taken 2 years later in the same 4 elevators (N = 2,132)

- Number of samples with a high kernel damage (> 10/100g) was reduced by 24% (P ≤ 0.01)

- Mean kernel damage (IDK) was 2.5/100g and 1.9/100g in the first and third years, respectively (P ≤ 0.05)
Economic Comparison: Sampling + Treating vs. Treating all Bins

Economic Analysis is only valid for concrete bins with wheat!

Parameters:
- Fumigant Type
- Pellets/Flask
- Flasks/Case
- $/Case (Fumigant Price)
- Pellets/1000 bu
- $/KWH (Elect. Cost)
- $/Bu (Wheat Price)
- Shrink Factor
- #Workers
- Wage

Results:

Fumigating All Sampled Bins
- Bins: 33
- Bushels: 646698

Fumigating Bins At Risk
- Bins: 8
- Bushels: 214340

Total Cost:
- $5,220
- $3,053

10/12/2001
Summary

- SGA Pro saved managers money and reduced fumigation by only fumigating bins at high risk for insect damage, rather than fumigating all the bins at an elevator.
- Although insects were detected in 80% of bins, only 20% of these bins required fumigation.
- Elevators that followed SGA Pro’s recommendations reduced the number of bins they normally fumigated by at least 50%.
- A grain-scouting company was started in 2002 that is currently using SGA Pro and the sampling tools that were developed in this project (currently being used in over 70 elevators on a contract basis).