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

Truck Sampler

Probe-trap

Bin Bottom

Moving Sample

Vacuum Probe Sampler

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.

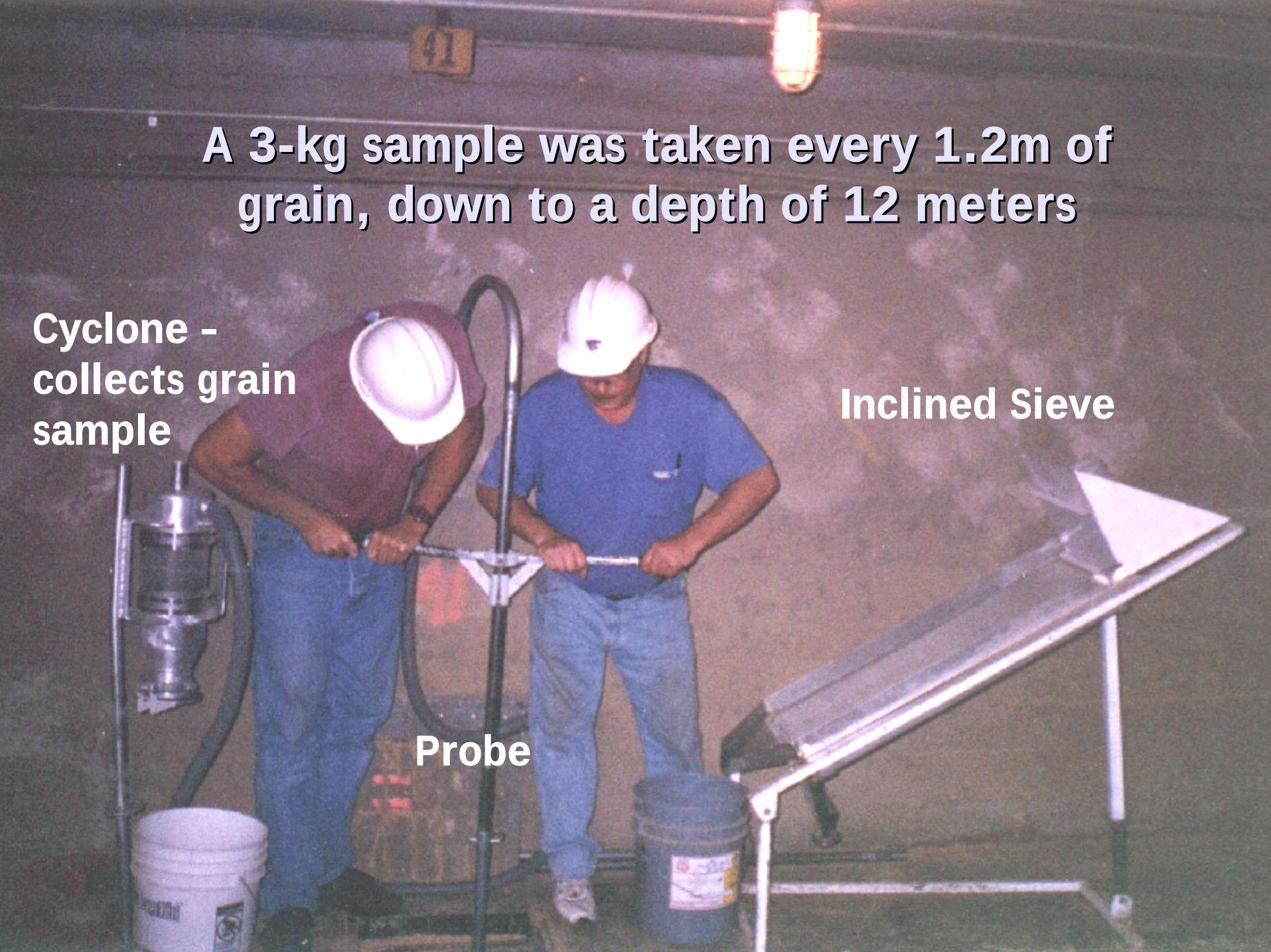
Vacuum Probe: Best IPM Sampling Method

- 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)

Vacuum Supply Line

Vacuum Pump


A 3-kg sample was taken every 1.2m of grain, down to a depth of 12 meters
Cyclone – collects grain sample
Inclined Sieve
Probe

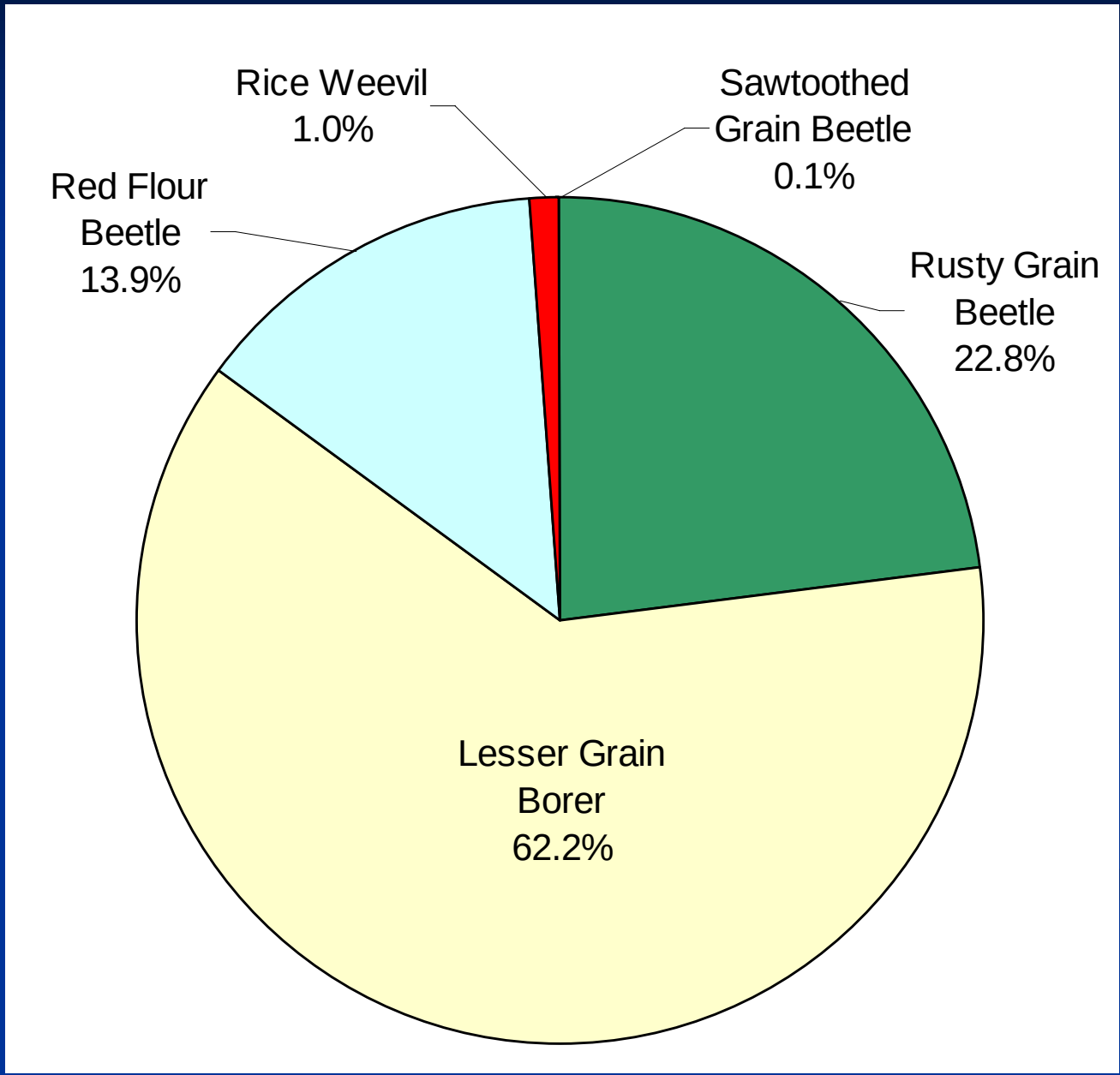

Vacuum-Probe Sections

A custom-designed inclined sieve is used to separate the insects from the grain

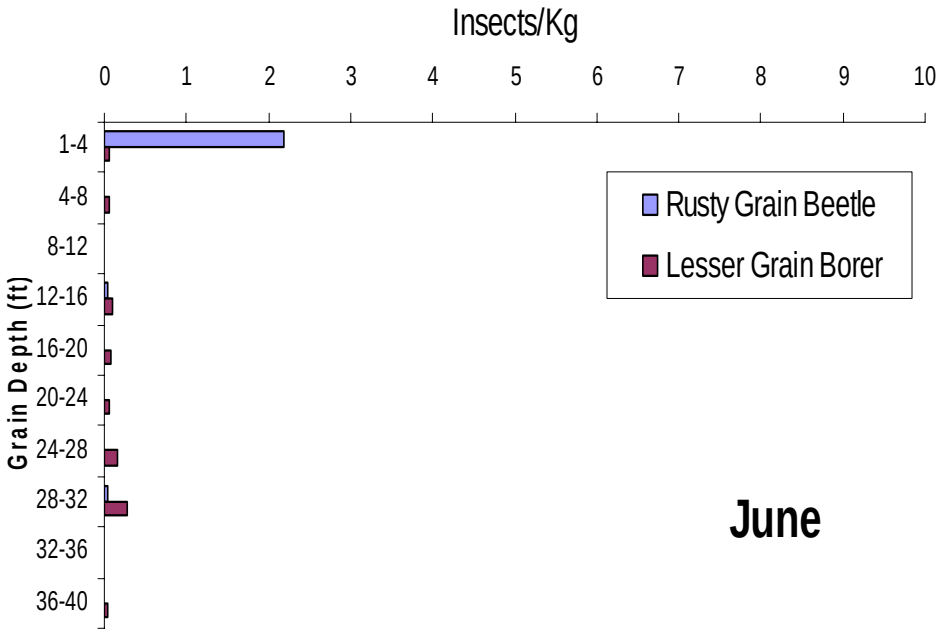
It allows us to rapidly separate insects from the 3-kg grain samples; so that we can leave the grain at the elevator and take only the fine material (which includes insects) back to the laboratory

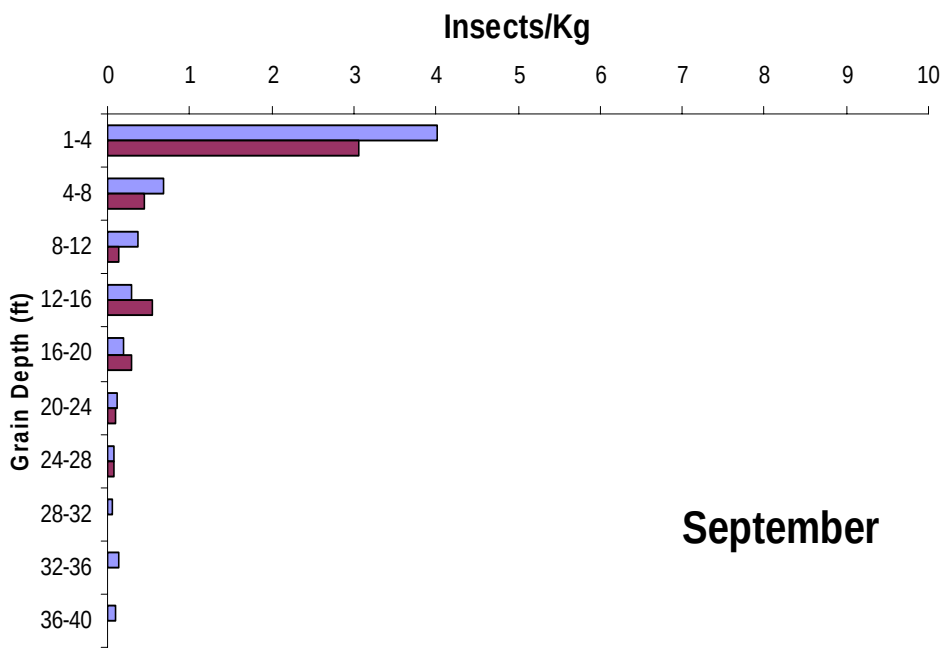
Insect Identification & Counting

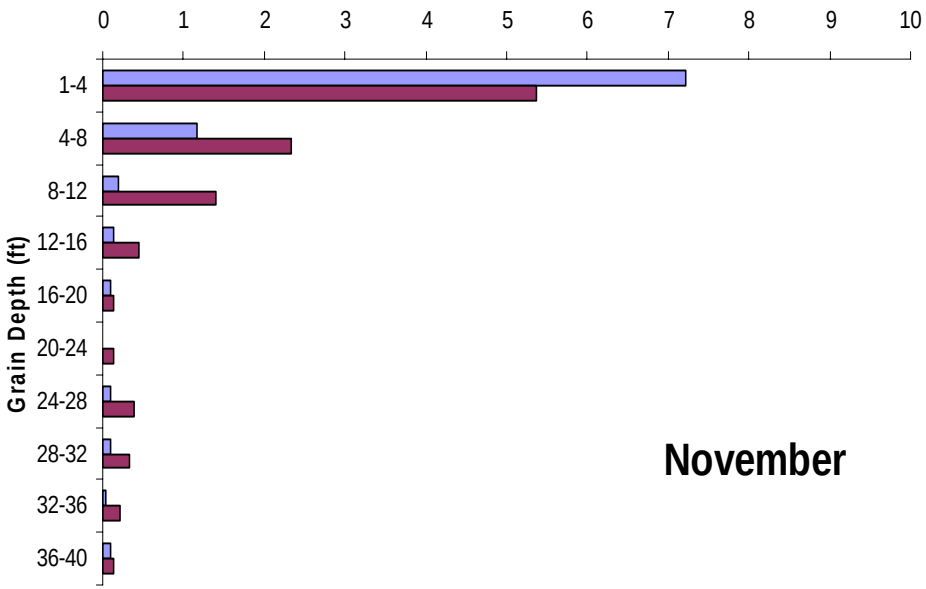
Insect Species Found in Stored Wheat

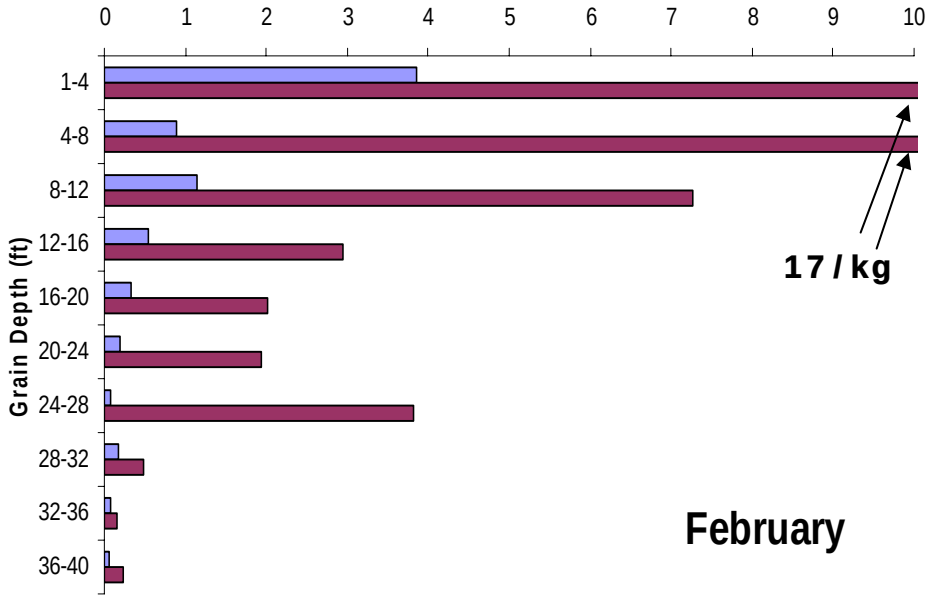


Seasonal Trends: Summer to Winter

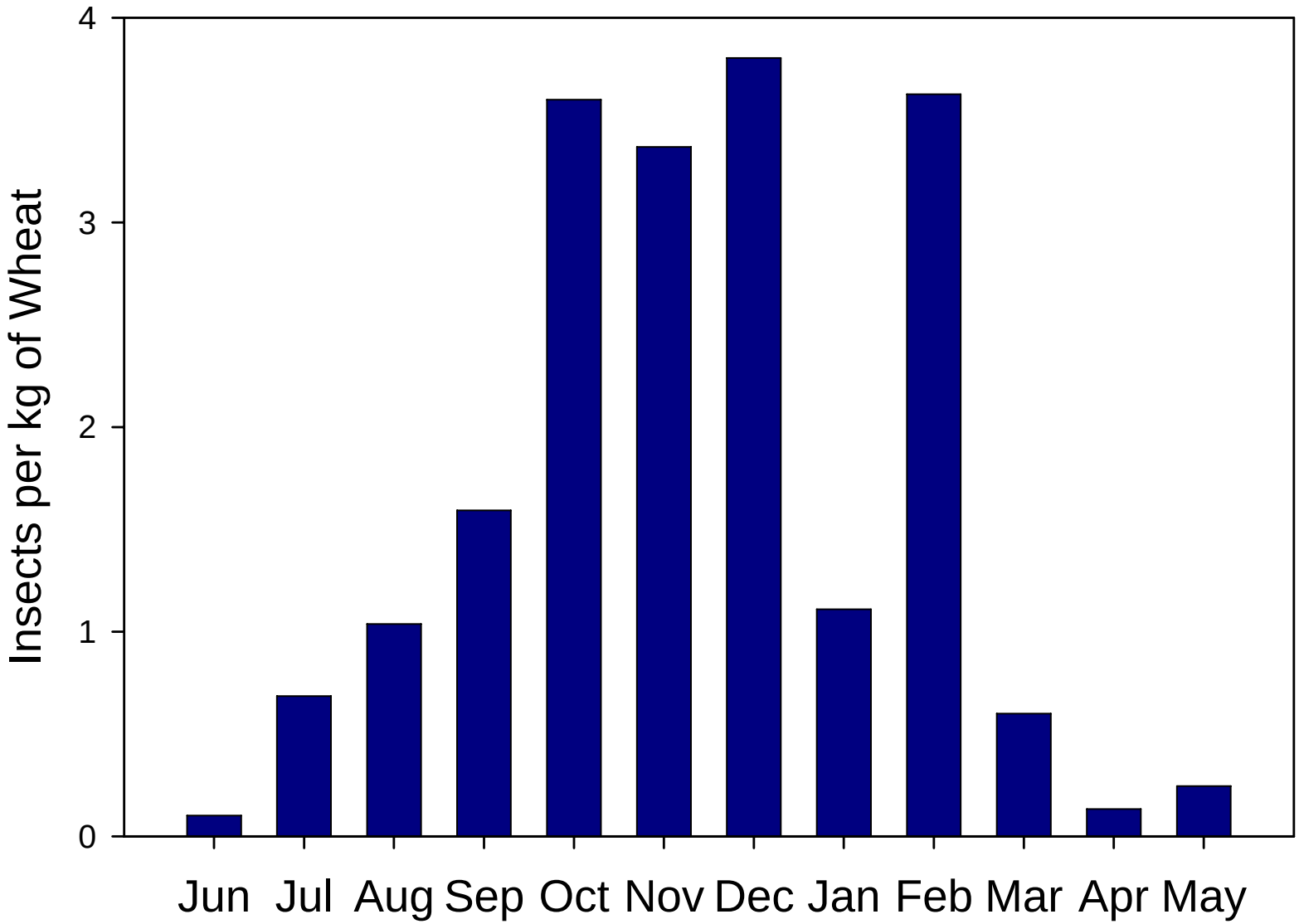




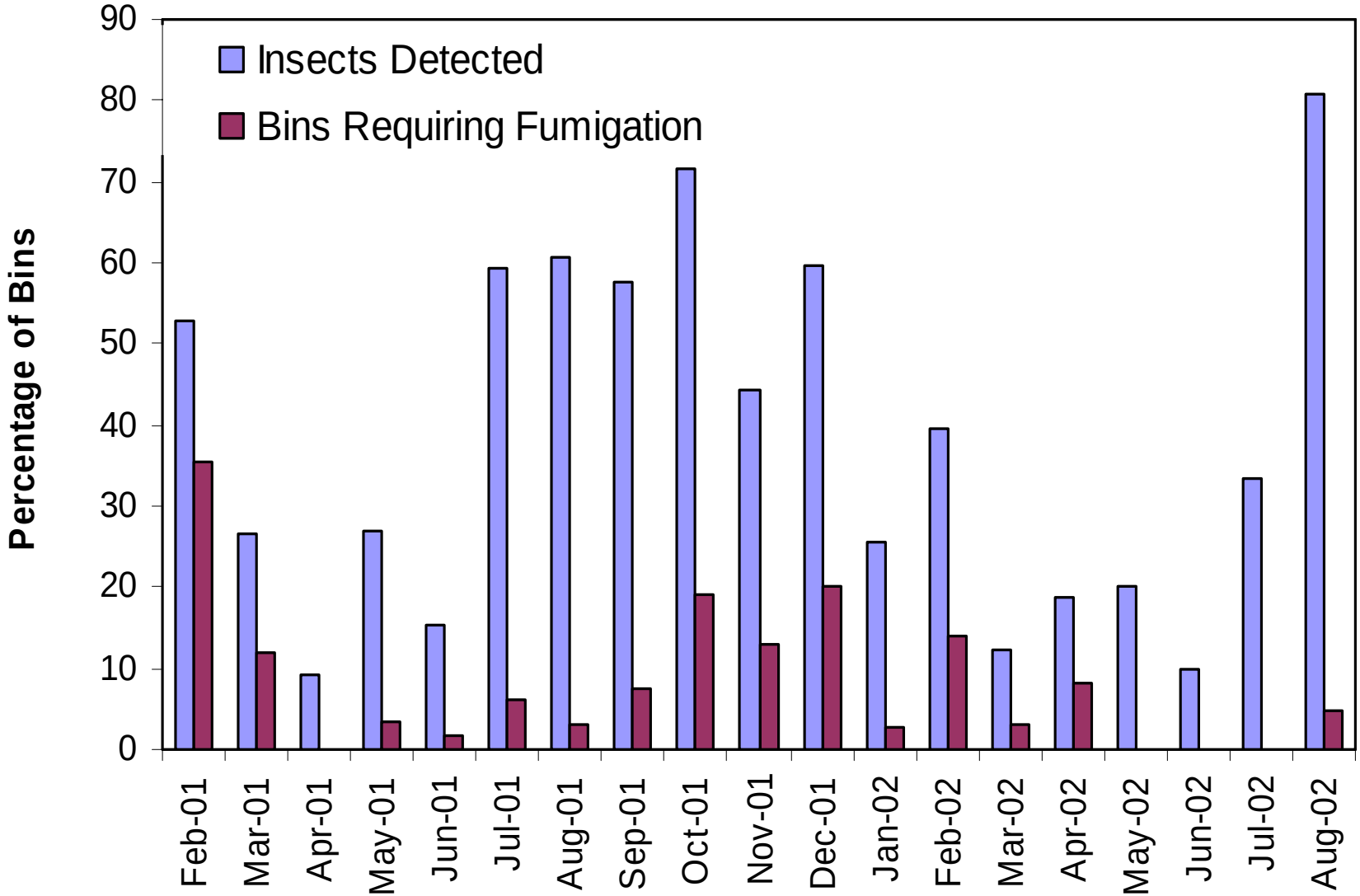




Seasonal Changes in Insect Density



Percentage of Bins Requiring Fumigation

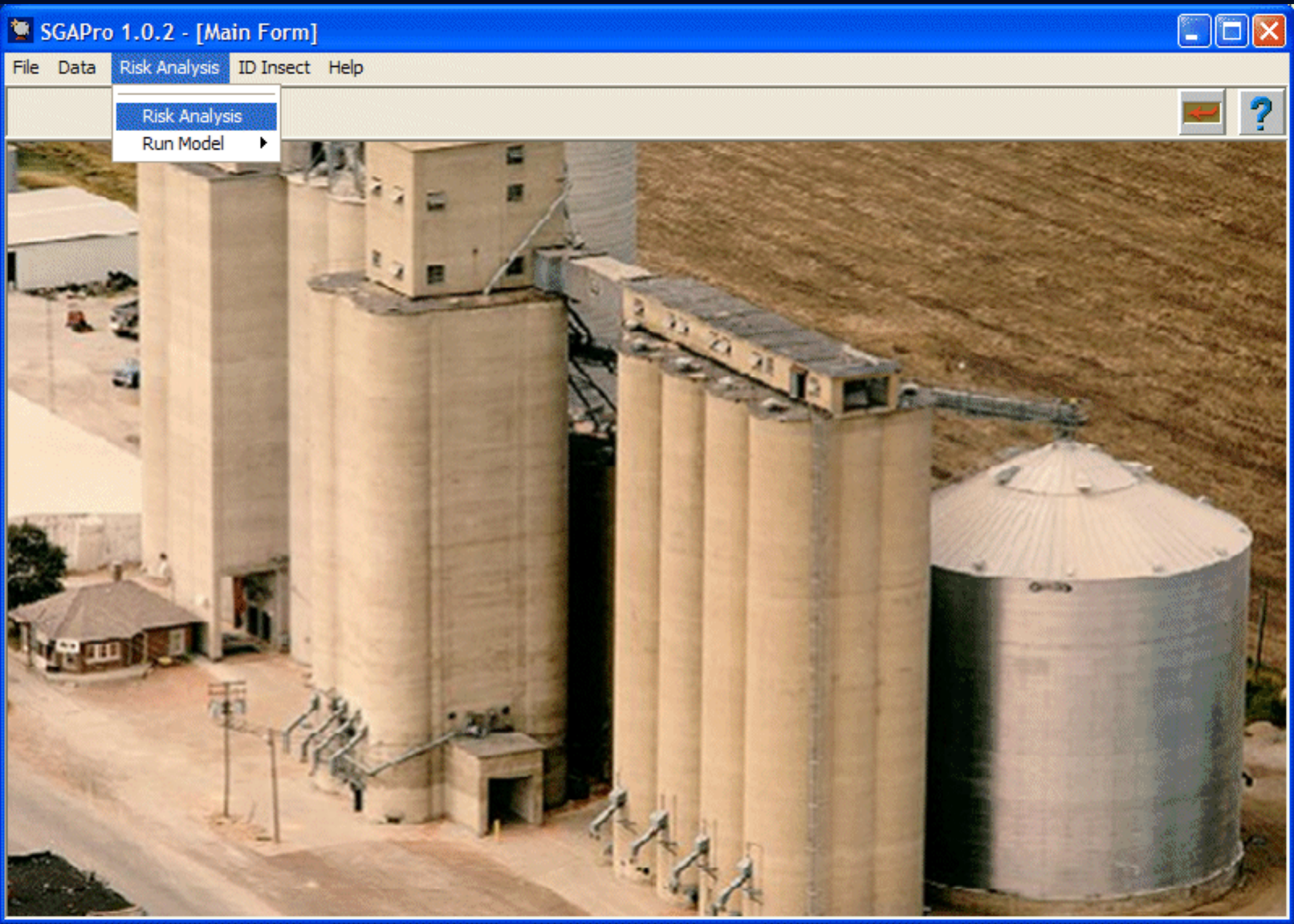


Stored Grain Advisor Pro

- 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

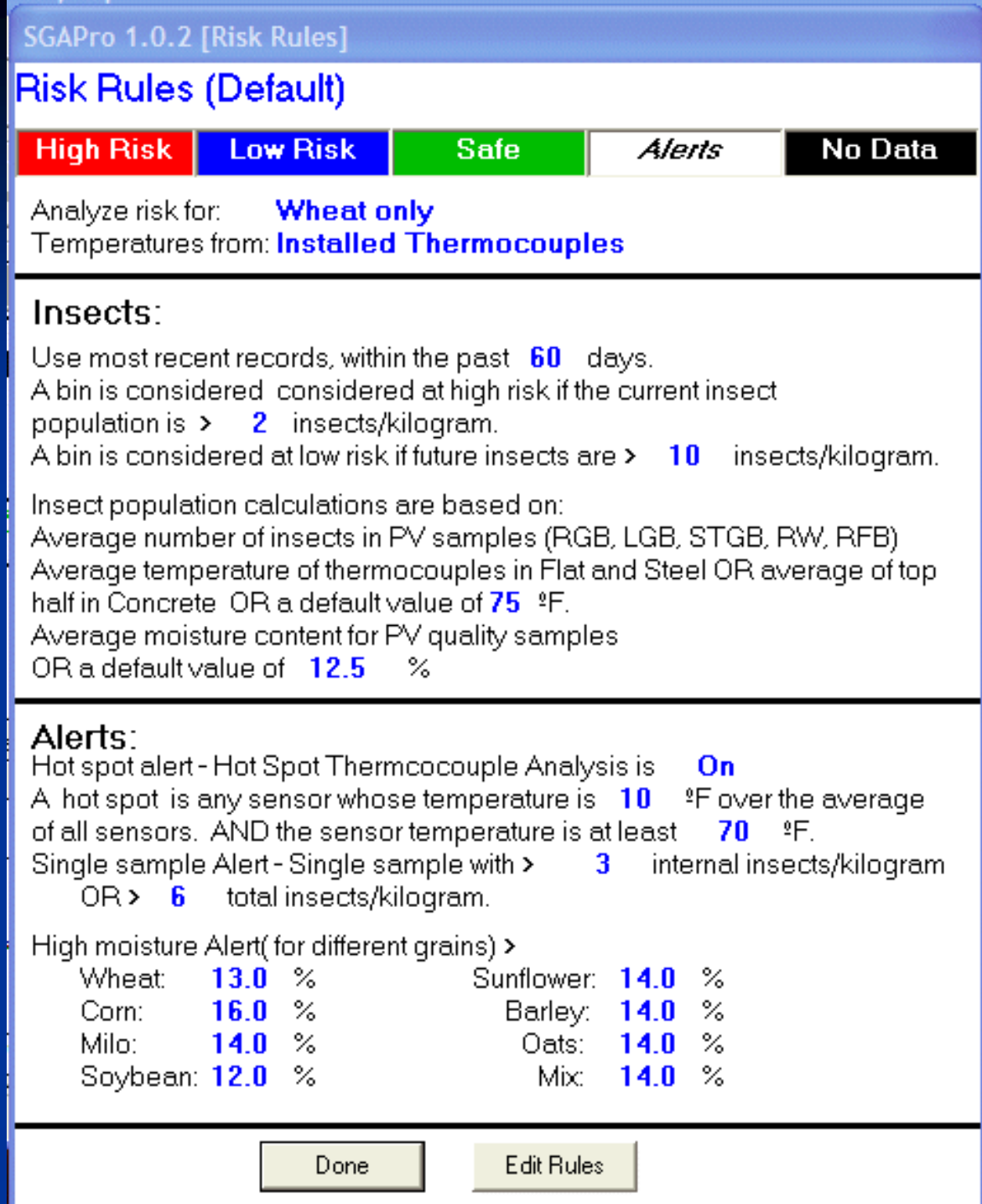
SGA Pro Decision Support Software

- 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


SGAPro 1.0.2 - [Main Form]
File
Data
Risk Analysis
ID Insect
Help
Risk Analysis
Run Model

Adjustable Risk Rules

Risk analysis rules can be adjusted by the user for insect thresholds, hot spots, and grain moisture thresholds



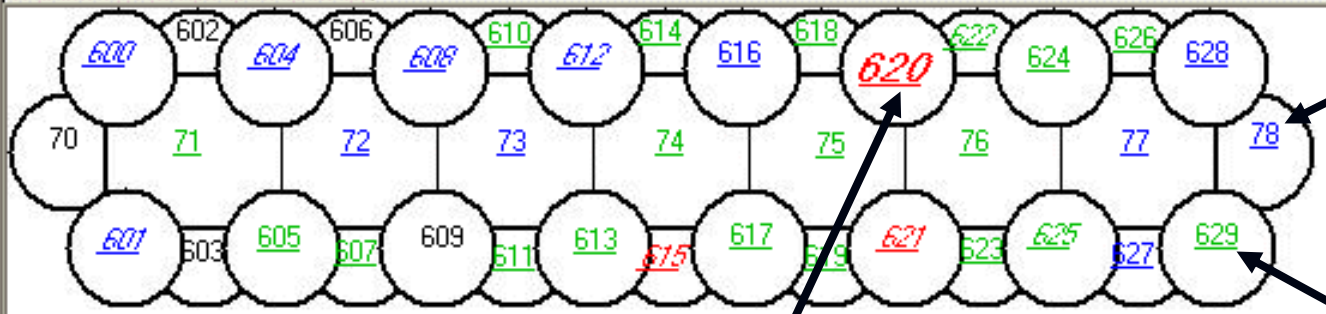
SGAPro 1.0.2 - [Risk Analysis]

File Help

Elevator: TSB

Done | Econ. Analysis | Type of rules: Default | Risk Rules | Exit Module

North | Head House | South



Bins in blue are at moderate risk for insect damage

Bins in red are at high risk for damage

Bins in green are safe from insect damage

Risk Analysis | Insect Data | Insect Graph | Thermocouple Data | Thermocouple Graph | Grain Quality Data | Bin Characteristcs | Bin Board Data

Grain	Moist	Temp.	IDK Insects	Insects/kilogram 9/13/2001	1 Month	2 months	3 Months
Wheat	12.9	81	28%	2.5	14.6	85.2	497.6
		Installed			Future Insect Densities		

Print: Abbre. Report | Full Report | Elev. Diagram

Recommendation for bin 620

Management Option:

Fumigate, cool Aeration
This grain is at risk, fumigate now. Prevent population regrowth by aerating the grain to 60 F.

Alerts:

Single Sample insect

Bin#: 620 | 10/11/2001

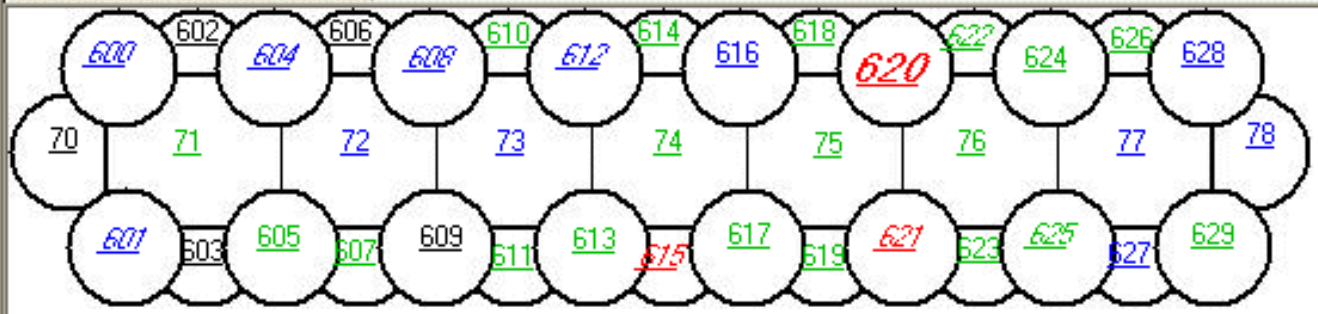
SGAPro 1.0.2 - [Risk Analysis]

File Help

Elevator: TSB

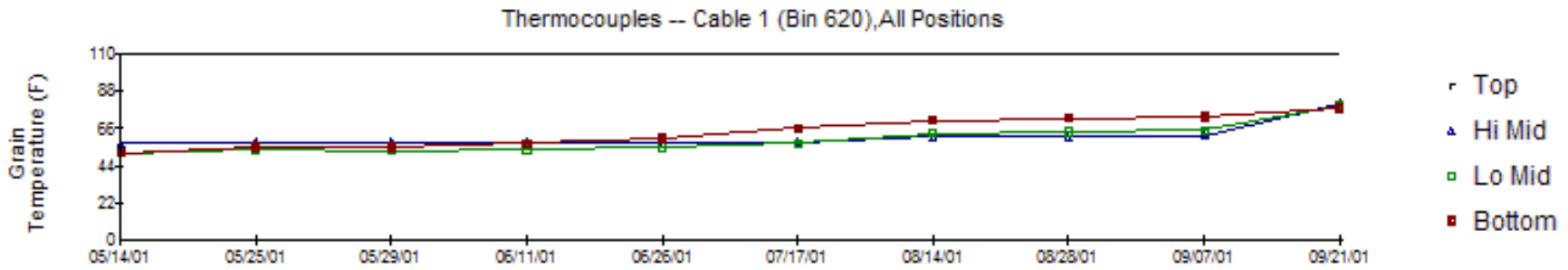
Done | Econ. Analysis | Type of rules: Default | Risk Rules | Exit Module

North | Head House | South



Risk Analysis | Insect Data | Insect Graph | Thermocouple Data | Thermocouple Graph | Grain Quality Data | Bin Characteristcs | Bin Board Data

All | Top | Hi Mid | Lo Mid | Bottom | Print Graph



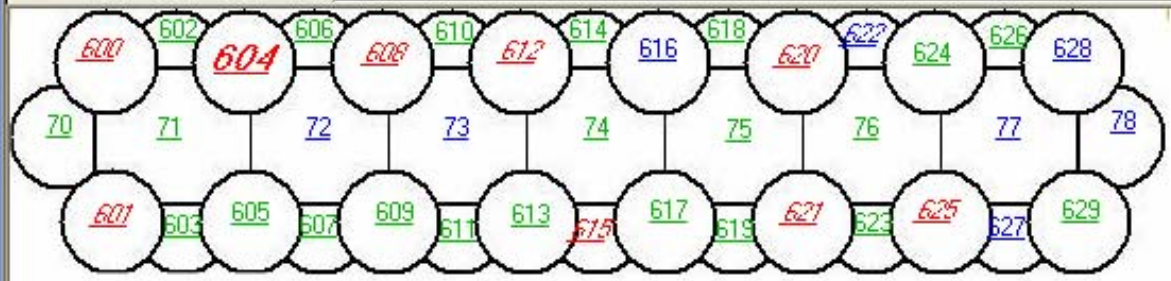
Bin#: 620 | 10/11/2001

SGAPro 3.0 - [Risk Analysis]

File Help

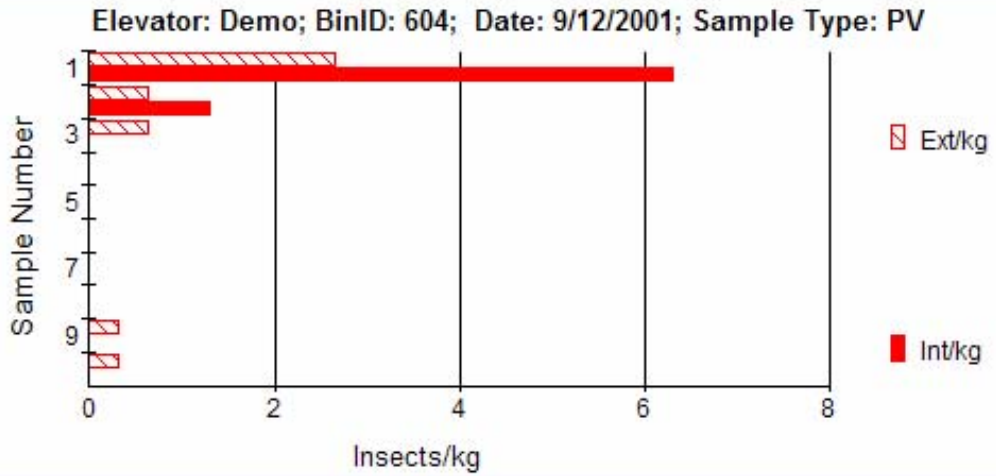
Elevator: Demo | Done | Econ. Analysis | Type of rules: Default | Risk Rules | Exit Module

North



Risk Analysis | Insect Data | Insect Graph | Thermocouple Data | Thermocouple Graph | Grain Quality Data | Bin Characteristcs

Data View (Months): 2 | Print Graph



Bin#: 604 | 10/12/2001

Manager's Report

Risk Report [SGAPro 1.0]

Zoom 100%

Bin	Risk	Internal	Current	1 Month	2 Month	3 Month	Alerts	Management Option	Date	Grain	Moist.	Temp.
522	Medium	0%	0.0	0.3	2.4	20.7		Resample by 11/10/2001	9/11/01	Wheat	11.6	93.9
523	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/11/01	Wheat	11.2	93.9
525	Medium	0%	0.0	0.3	2.4	20.9		Resample by 11/10/2001	9/11/01	Wheat	11.8	95.6
526	Medium	0%	0.1	1.3	12.5	120.5		Consider fumigation.	9/10/01	Wheat	12.2	93.6
527	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/10/01	Wheat	11.4	93.4
528	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/10/01	Wheat	11.8	93.6
529	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/10/01	Wheat	11.8	94.1
530	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/10/01	Wheat	11.8	94.1
600	Medium	30%	1.8	15.4	132.4	1135.5	SS	Fumigate, cool Aeration	9/12/01	Wheat	11.6	93.3
601	Medium	88%	0.8	3.0	11.1	41.4	SS	Consider fumigation.	9/12/01	Wheat	12.2	78.2
604	Medium	62%	1.2	2.8	6.5	15.0	SS	Cool w/ Aeration	9/12/01	Wheat	12.0	74.7
605	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/12/01	Wheat	12.4	60.4
607	Safe	9%	0.7	0.7	0.7	0.7		No action required.	9/12/01	Wheat	11.6	70.6
608	Medium	68%	1.7	8.1	39.5	192.4	SS	Cool w/ Aeration	9/12/01	Wheat	12.1	81.0
610	Safe	0%	0.8	0.8	0.8	0.8		No Action Required	9/12/01	Wheat	11.8	58.8
611	Safe	0%	0.1	0.5	2.0	7.6		No action required.	9/12/01	Wheat	11.0	81.4
612	Medium	66%	1.3	11.0	95.3	826.5	SS	Fumigate, cool Aeration	9/13/01	Wheat	12.7	86.5
613	Safe	0%	0.0	0.0	0.0	0.0		No Action Required	9/13/01	Wheat	12.0	58.7
614	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/13/01	Wheat	11.0	81.0
615	High	0%	4.3	19.1	83.8	368.2	SS	Fumigate	9/13/01	Wheat	11.6	81.2
616	Medium	60%	0.5	4.9	48.8	482.0		Cool w/ Aeration	9/13/01	Wheat	12.6	89.5
617	Safe	33%	0.0	0.0	0.0	0.0		No Action Required	9/13/01	Wheat	12.6	58.6
618	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/13/01	Wheat	11.0	61.3
619	Safe	0%	0.0	0.0	0.0	0.0		No action required.	9/13/01	Wheat	12.0	79.9
620	High	28%	2.5	14.6	85.2	497.6	SS	Fumigate, cool Aeration	9/13/01	Wheat	12.9	81.0
621	High	0%	2.8	2.8	2.8	2.8	SS	Fumigate	9/13/01	Wheat	12.6	62.4

Pages: 2

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

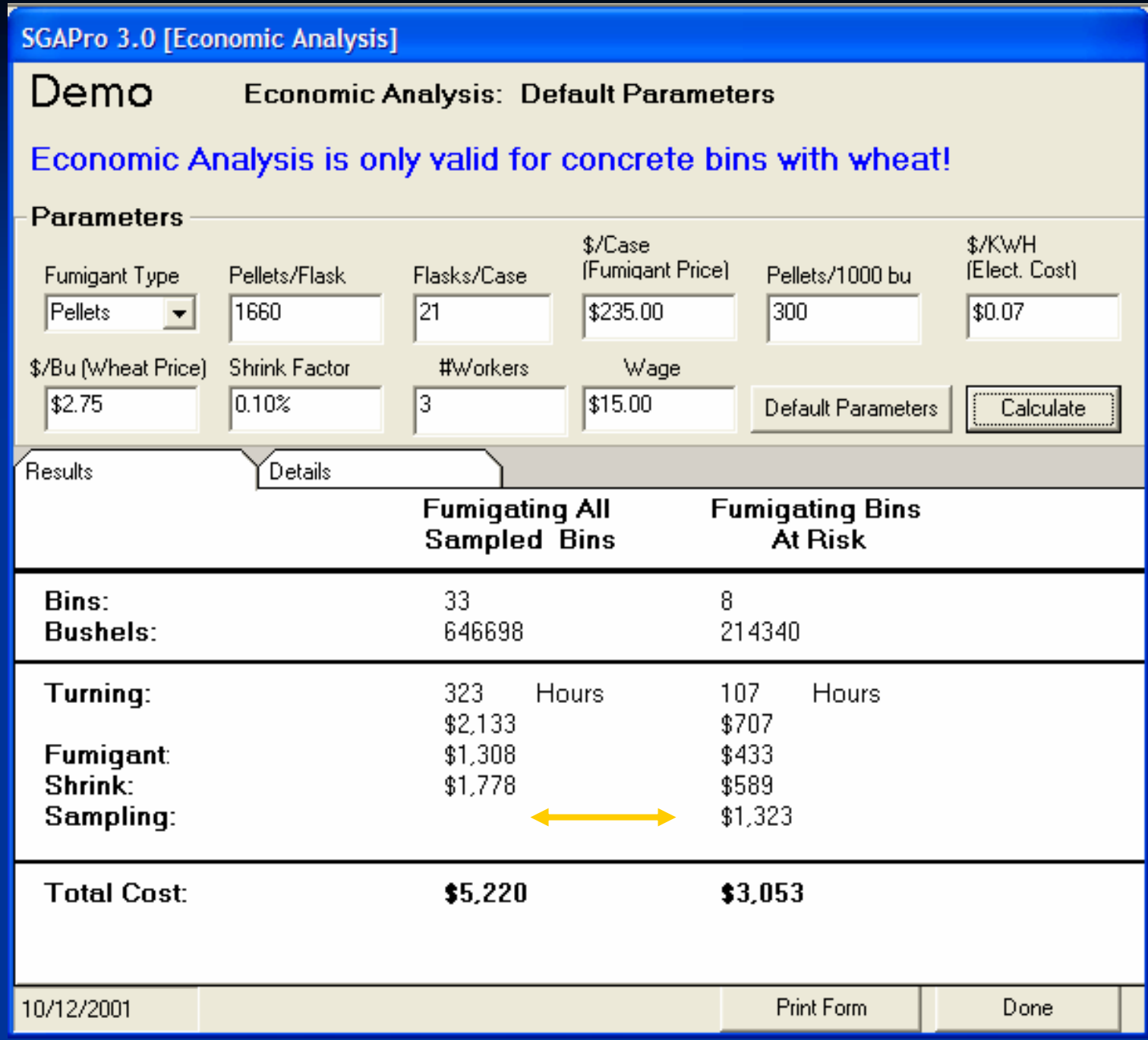
The number of correct predictions by Stored Grain Advisor Pro, and type A and B errors for elevator bins in Kansas and Oklahoma.							
	N	Correct	%	Type A[1]	%	Type B[2]	%
Kansas	399	285	71.4	2	0.5	112	28.1
Oklahoma	133	107	80.5	0	0.0	26	19.5

[1]Type A errors: software predicts "safe" (< 2 insects per kg, and actual density in 6 weeks is > 2 insects/kg of wheat.
[2]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% ($P \leq 0.01$)
- Mean kernel damage (IDK) was 2.5/100g and 1.9/100g in the first and third years, respectively ($P \leq 0.05$)

Economic Comparison: Sampling + Treating vs. Treating all Bins



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)