Economics of Insect Control in Rice Storage and Processing

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Insect Control Changing

- Methyl bromide (main fumigant for processing facilities) is almost completely phased out (ozone depleter)
- Additional concerns about fumigants in general
  - Worker safety
  - Insects developing resistance, especially to phosphine

  → **Intensive search for economical alternatives, especially Integrated Pest Management (IPM)**

Integrated Pest Management (IPM)

- Monitoring-based decision making
- Multiple control strategies (possibly including chemicals)

"IPM is a balanced use of multiple control tactics – biological, chemical, and cultural – as is most appropriate for a particular situation in light of careful study of all factors involved" (Way 1977).

In Search of the Holy Grail: Economics of Insect Control in Rice Storage and Processing

Is aeration (or sampling, or ????) economical?

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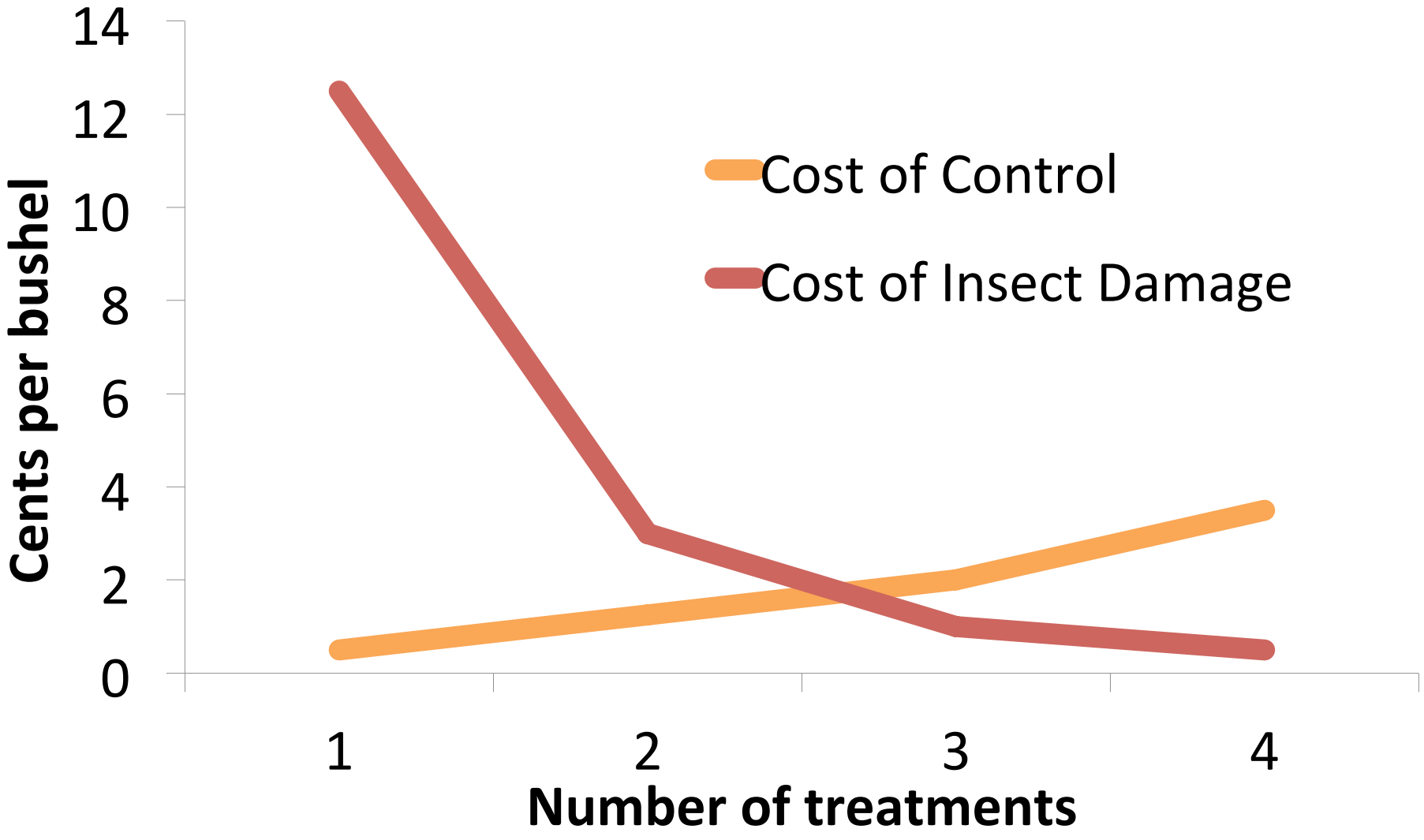
It Depends!

Insect Control is an Economic Compromise



Previous Work on Economics of Controlling Insects in Stored Products

- Focused mostly on bulk storage (e.g. Adam et al. 2010)
  - Relatively homogeneous insect environment
  - Temperature, humidity vary over time
  - Good knowledge about insect growth
  - Well-defined costs of insect damage

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Rice Weevil

Rice Weevil

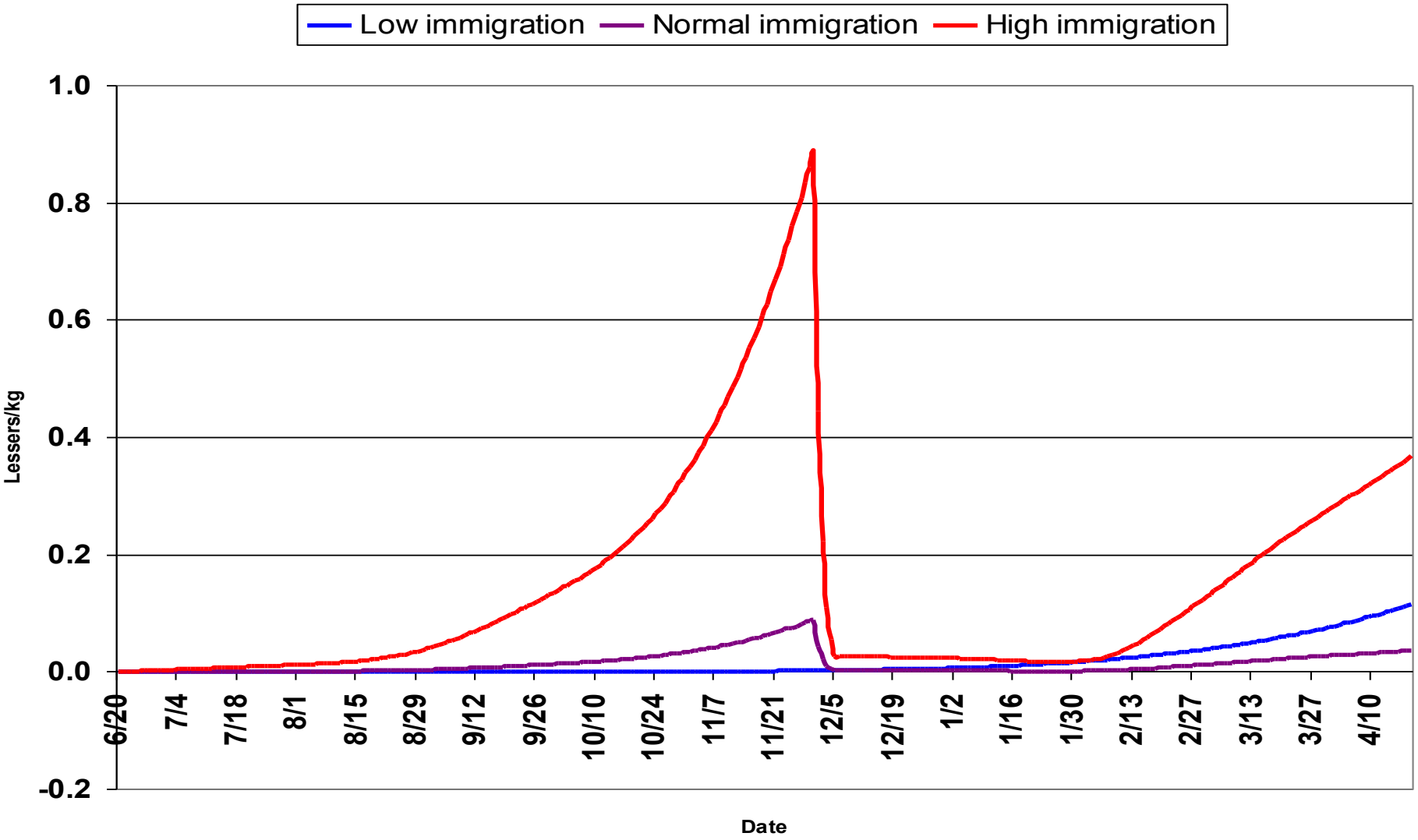
Lesser Grain Borers Attacking Wheat

Controlling Insects in Stored Grain

- Insect Control methods:
  - Phosphine fumigation
  - Aeration (esp. with automatic aeration controllers)
  - Sanitation

- Fumigation - How often? When?
  - Fumigating too early → need to repeat (costly)
  - Fumigating too late → insect damage (costly)

Insect Population, Before & After Fumigation
Three Insect Immigration Rates



Controlling Insects in Stored Grain

- Aeration
  - When to turn fans on and off
  - Effect of aeration on moisture content, grain quality
- Sanitation
  - Always good – but it does cost time and money

Controlling Insects in Processing Facilities

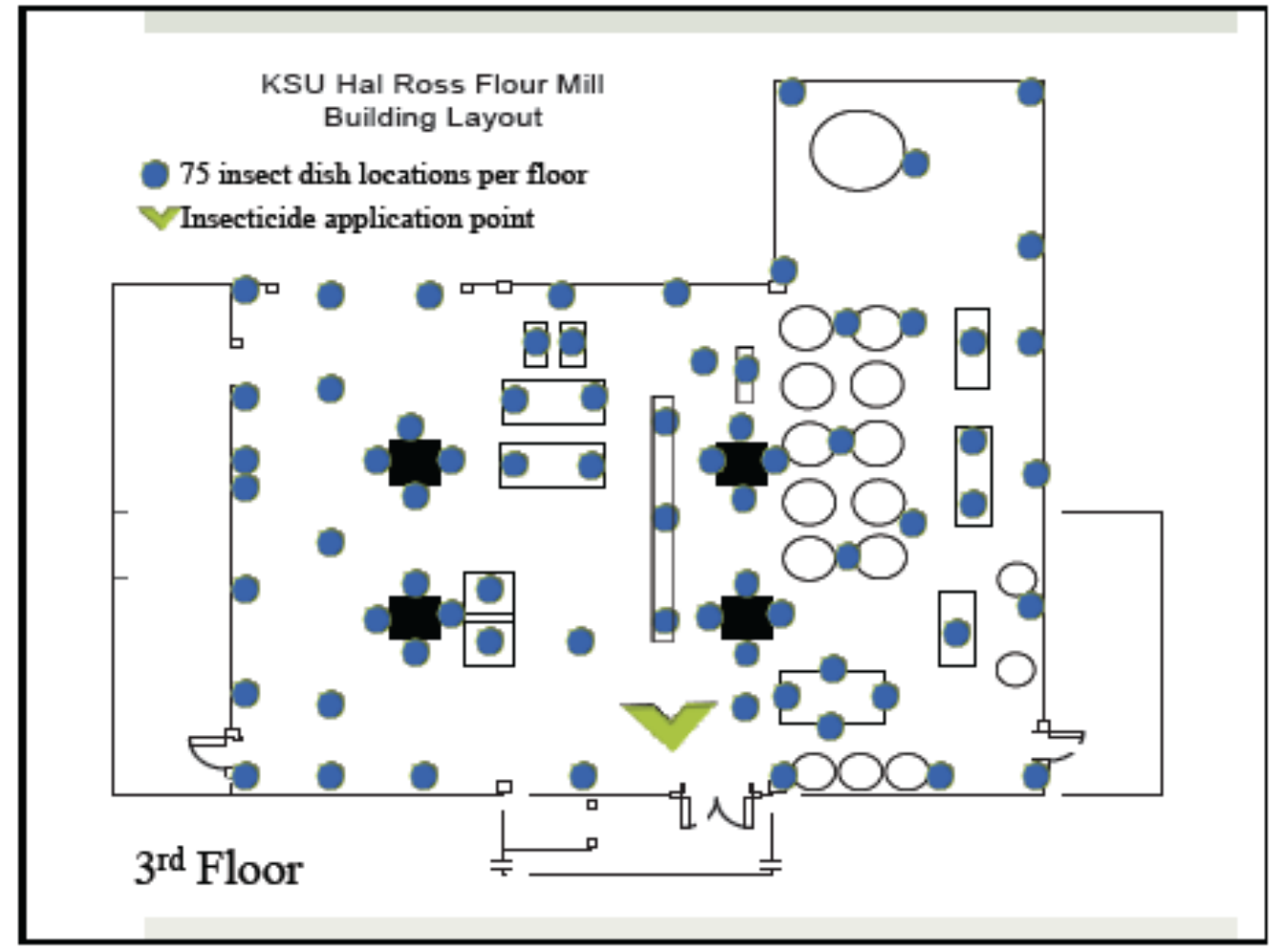
- Process environment, not storage
  - Temperature/humidity less variable, other factors more variable
- Heterogeneous environment → less knowledge about insect growth
- **Closer to final consumption → cost of insects less defined; likely much higher**

Red Flour Beetle

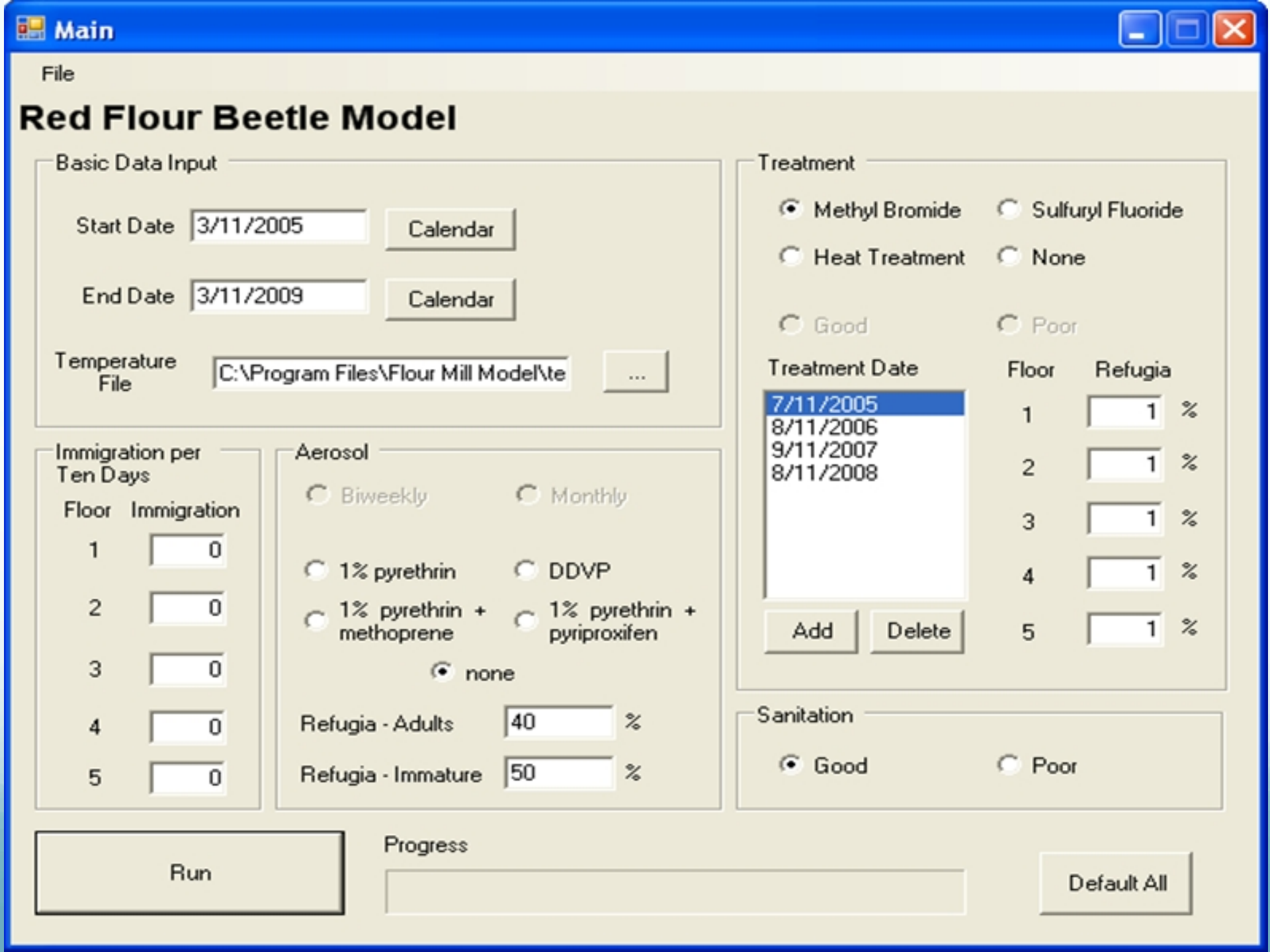
Red Flour Beetle

(consumers probably don't appreciate the protein supplement in their Cheerios!)

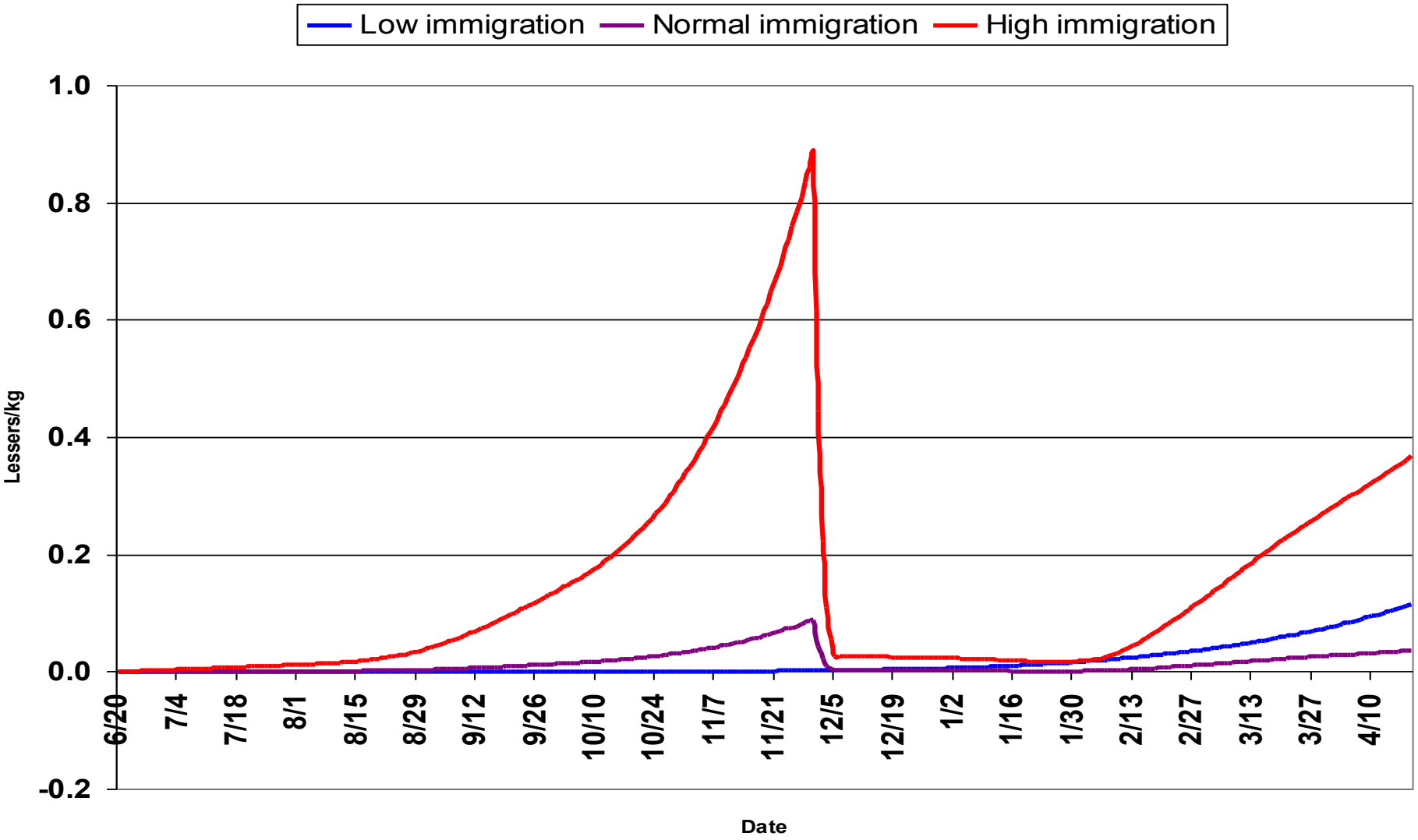
Sample Insect Trap Layout



Source: Campbell 2013.


Main
File
Red Flour Beetle Model
Basic Data Input
Start Date
3/11/2005
Calendar
End Date
3/11/2009
Calendar
Temperature File
C:\Program Files\Flour Mill Model\te
...
Treatment
Methyl Bromide
Sulfuryl Fluoride
Heat Treatment
None
Good
Poor
Treatment Date
7/11/2005
8/11/2006
9/11/2007
8/11/2008
Add
Delete
Floor
Refugia
1
1
%
2
1
%
3
1
%
4
1
%
5
1
%
Immigration per Ten Days
Floor
Immigration
1
0
2
0
3
0
4
0
5
0
Aerosol
Biweekly
Monthly
1% pyrethrin
DDVP
1% pyrethrin + methoprene
1% pyrethrin + pyriproxifen
none
Refugia - Adults
40
%
Refugia - Immature
50
%
Sanitation
Good
Poor
Run
Progress
Default All

Insect Population, Before & After Fumigation
Three Insect Immigration Rates



Texas A&M AgriLife model

- Considers relevant factors:
  - Temperature/humidity
  - Insect immigration rate
  - Duration of storage
  - Type of insect
  - …

  Predicts insect growth so you can evaluate alternatives and compare costs and benefits (your choice – it depends on your situation!):

About This Program
Account Info
Creat Profile
View/Edit Profile
Run Profile
Results and Analysis
Weather Data
Logout
Credits
Contacts
Feedback

User: Brianadam

Display options

Profile: Farm 2015 | Aeration dynamics | Pest dynamics | Sensitivity Analysis

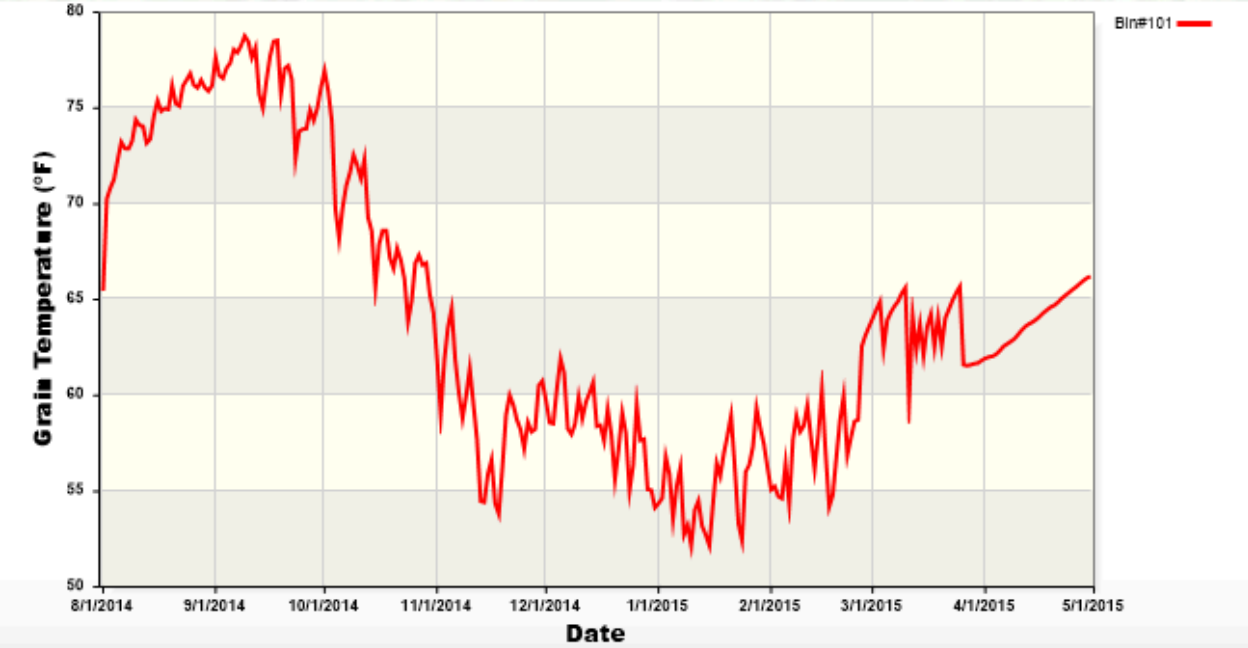
Average Grain Temp | View Chart | View Data | Download Data

Show selected bins in a single figure | Show selected bins in seperated figures

Select bins to display

#101 | Select all | Clear | Hide parameters

Aeration Dynamics



Finding the Best Strategies

- Simulate insect control strategies:
  - Fumigation
  - Aeration
  - Sanitation
  - …

Growth model predicts number of insects

Cost of Insect Control - Treatment Cost

Economic engineering used to estimate cost of each kind of treatment

Cost of Insect Damage: Stored Grain

- For stored grain:
  - Market discounts
  - Buyer discounts
  - Rejected shipments
  - Loss of buyer

Cost of Insect Damage: Processing

- For processed product, estimating loss due to insects is difficult
  - Rejected shipments
  - Loss of customer trust (“I’ll never buy Cheerios again!”)
  - Recall cost
- Probability might be low, but cost might be very high

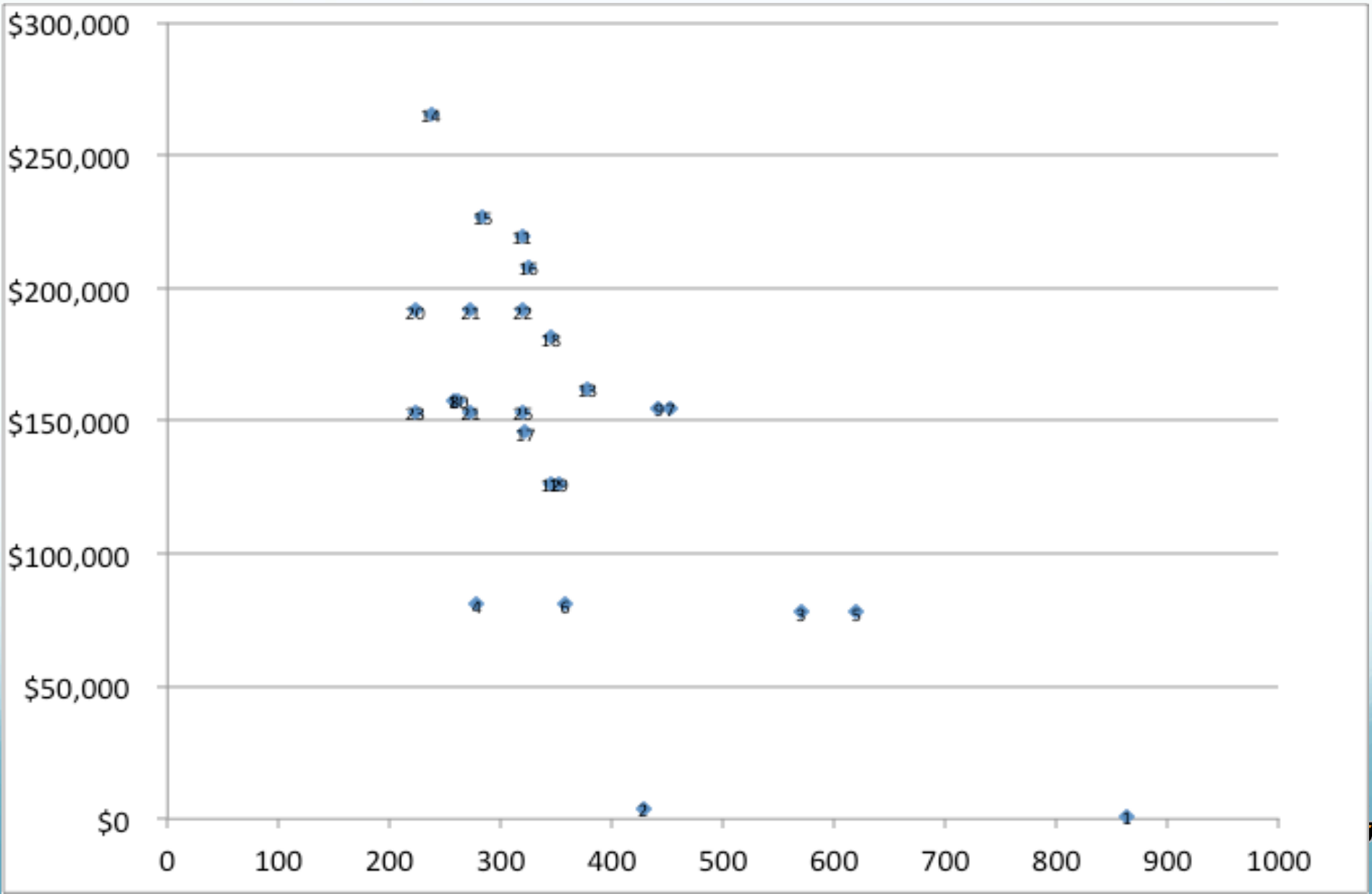
Evaluate Tradeoffs

→Minimize insect control cost subject to target level of insects (managers likely know what level of control they need to be safe)

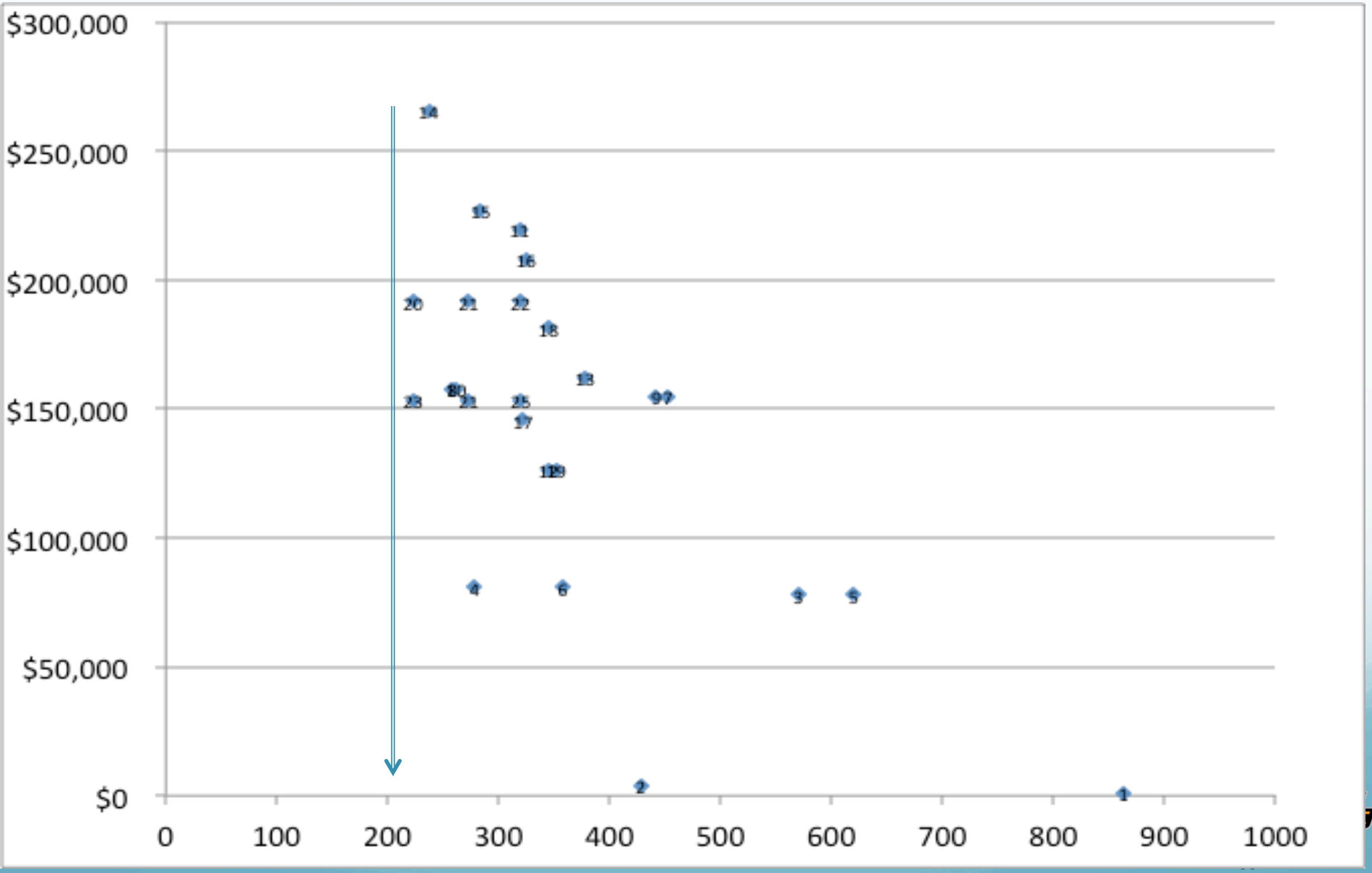
For each control method:

Plot Cost of Control vs. Max # of Insects Permitted

Cost of Control vs. Max # Insects



Cost of Control vs. Max # Insects



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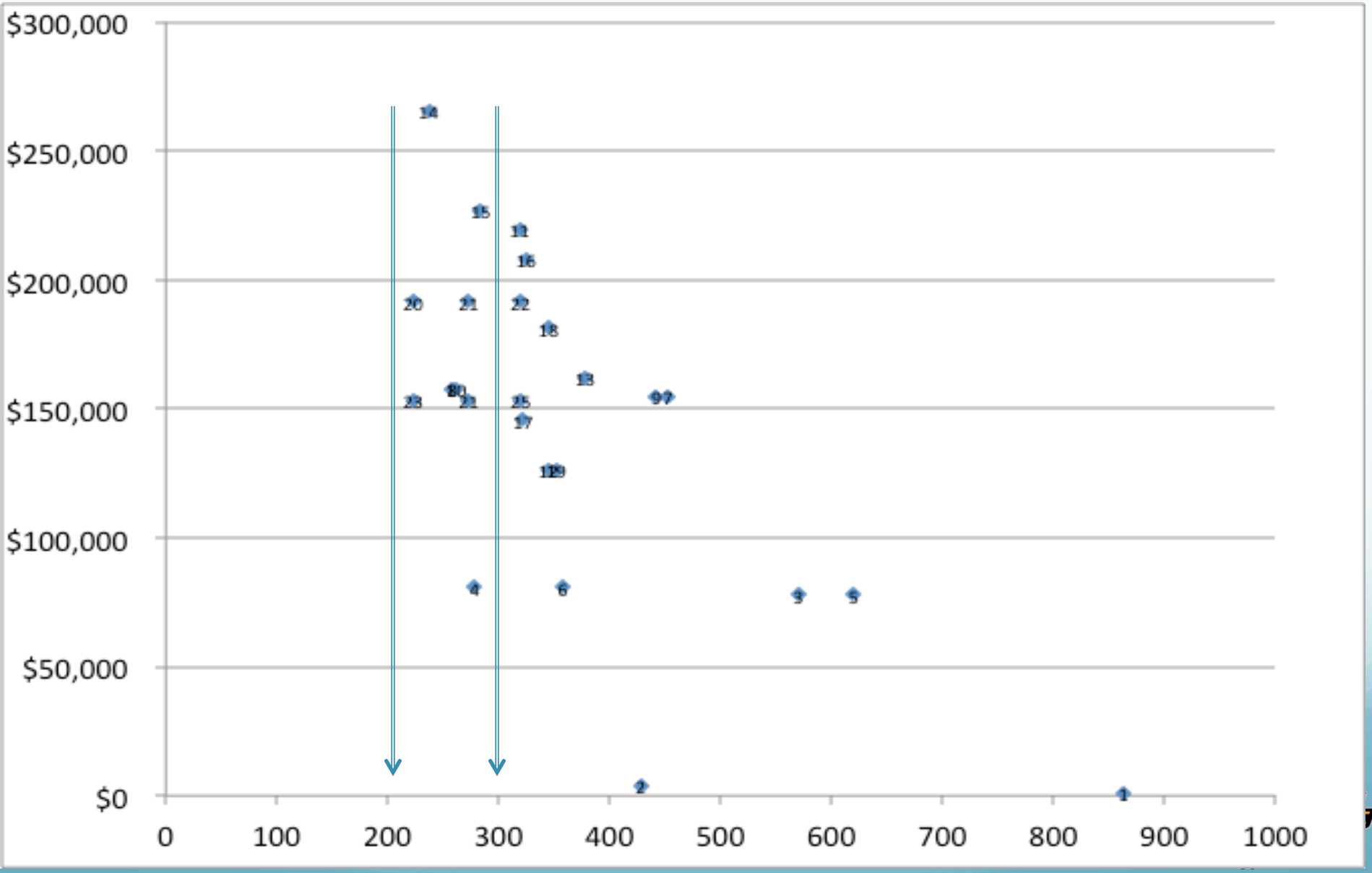
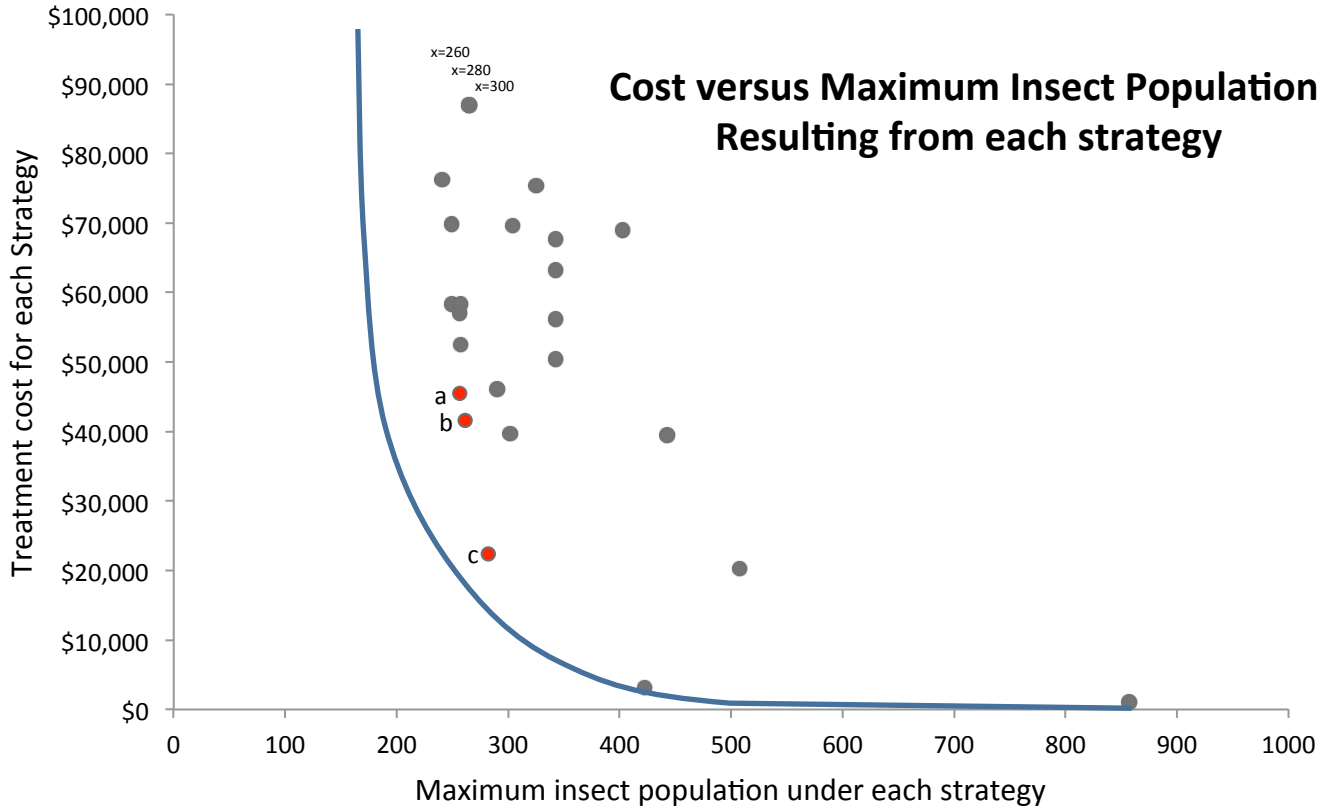


Whole-facility treatments

Strategies closer to the cost frontier curve are more cost-efficient



Lowest Cost Strategies (results for a specific facility)

Point a: Monitoring-based fumigation (fumigating when monitoring shows more than 250 insects), with good sanitation - when goal is 240 insects or less

Point b: Calendar-based fumigation 2x/year, with good sanitation - when goal is 200 insects or less

Point c: Calendar-based fumigation 1x/year, with good sanitation - when goal is 260 insects or less:

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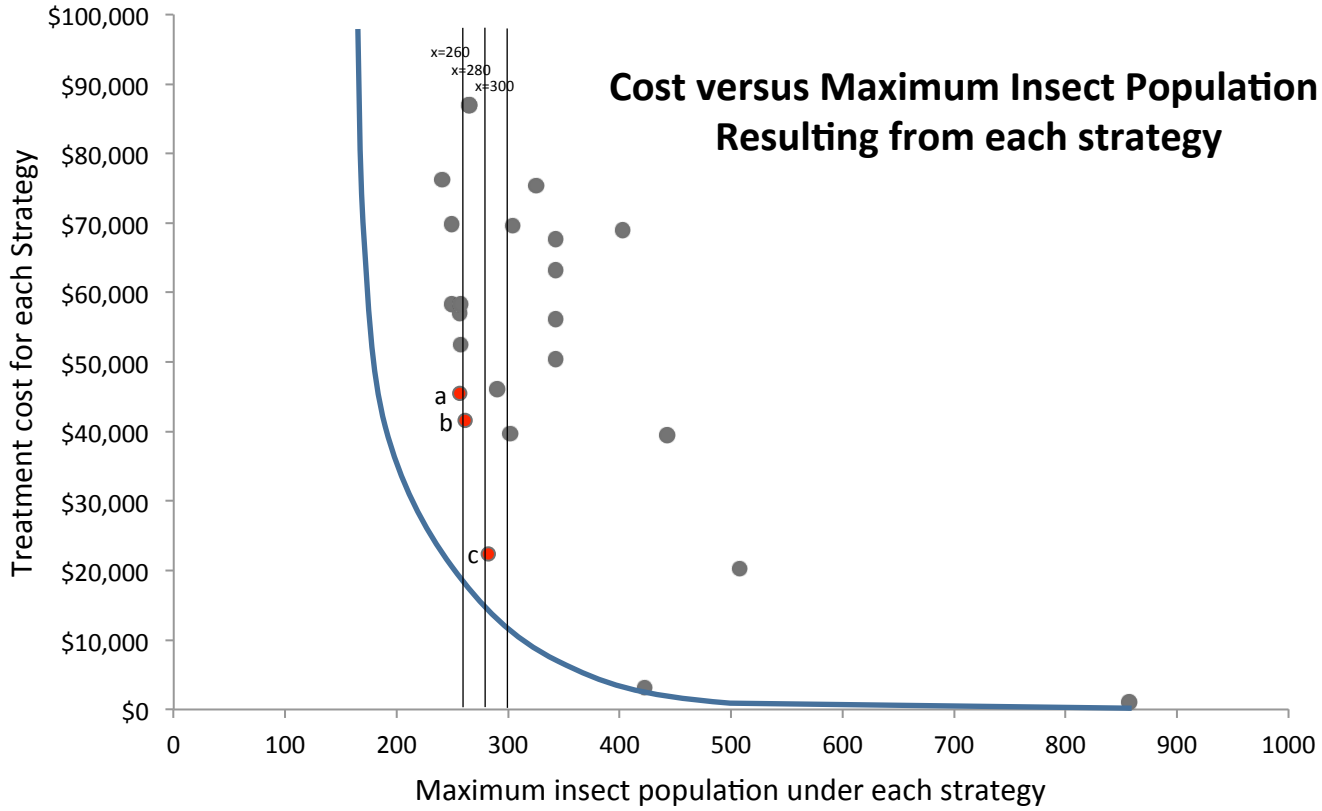

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For Your Situation:

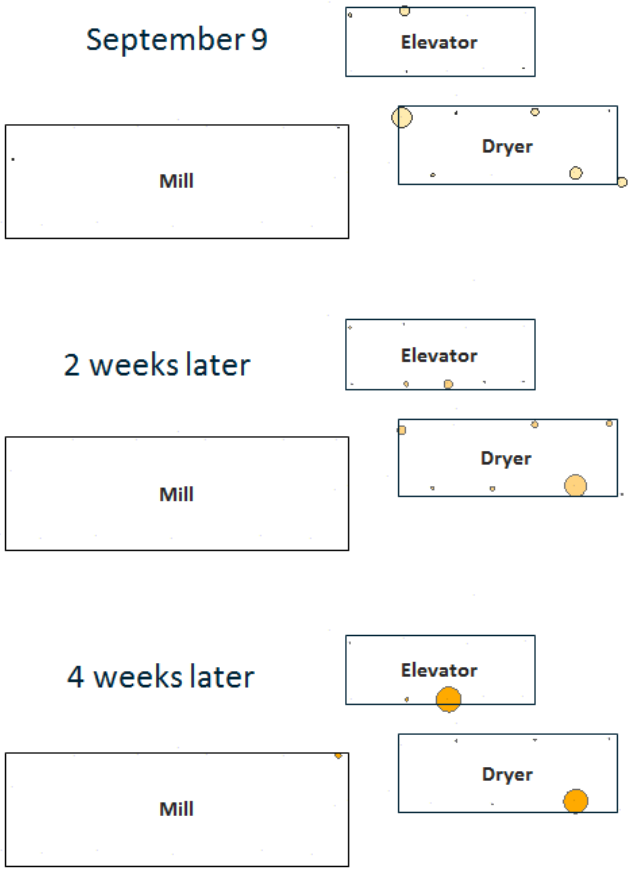
Use AgriLife model to:

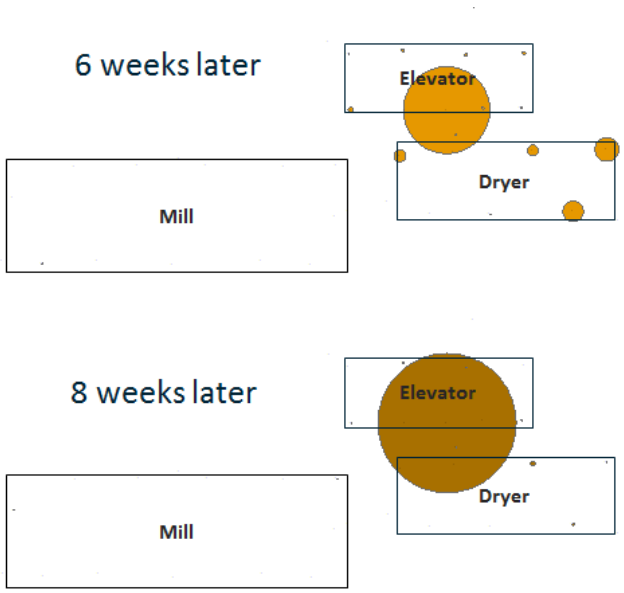
1) Create your facility profile
2) Predict insect growth for alternative strategies
3) Calculate costs (stay “tuned” to website for more information)
4) Evaluate tradeoffs

Can we do better?

- For a processing facility, targeted treatments may be a way to reduce probability of insect damage without substantially increasing control costs.

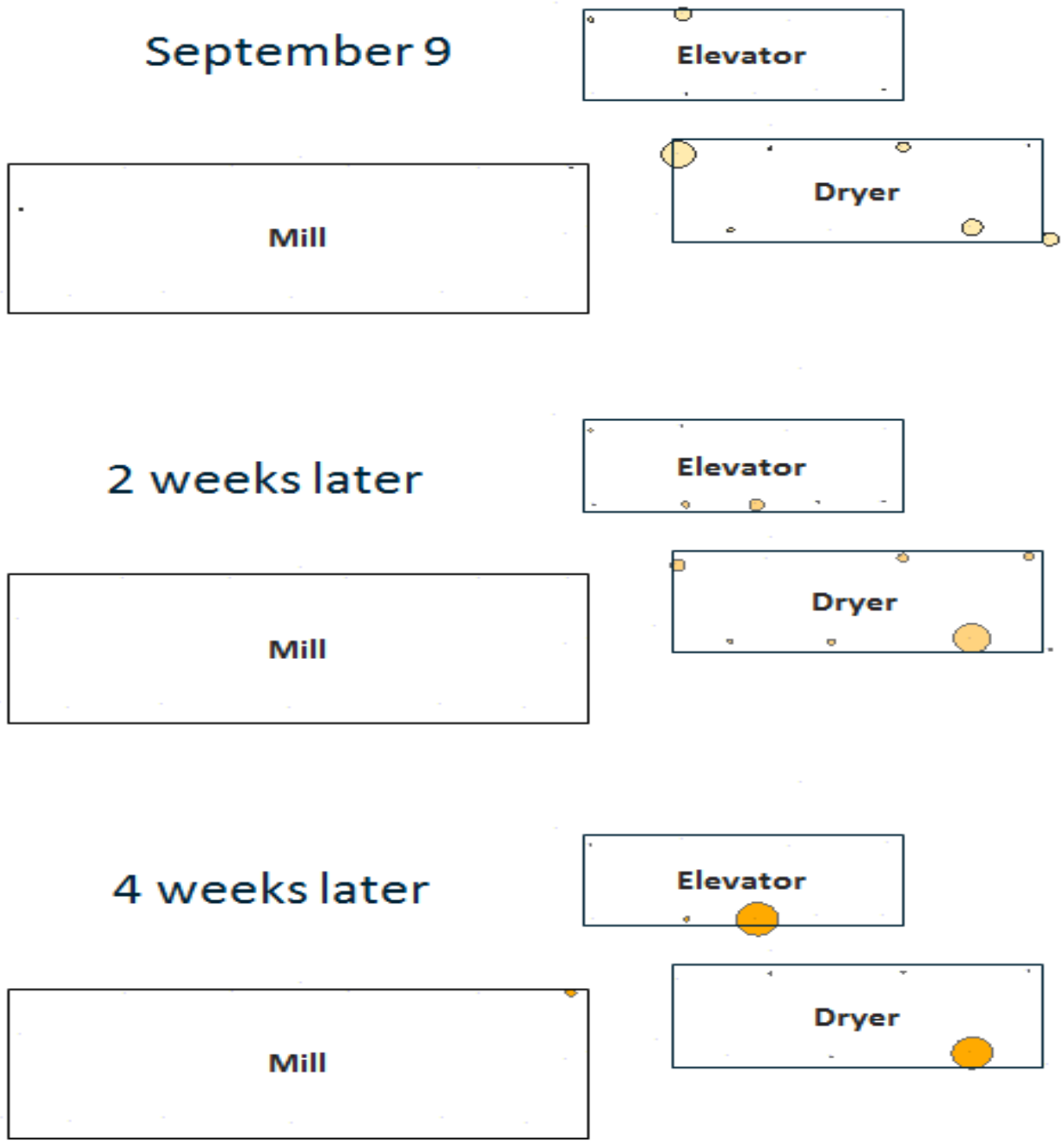
Targeted treatments – for areas in which insects grow faster

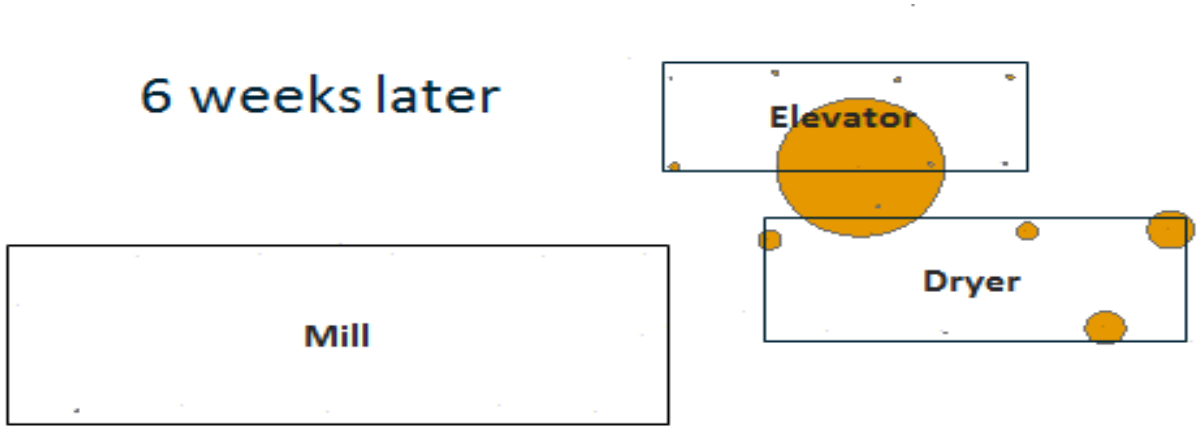


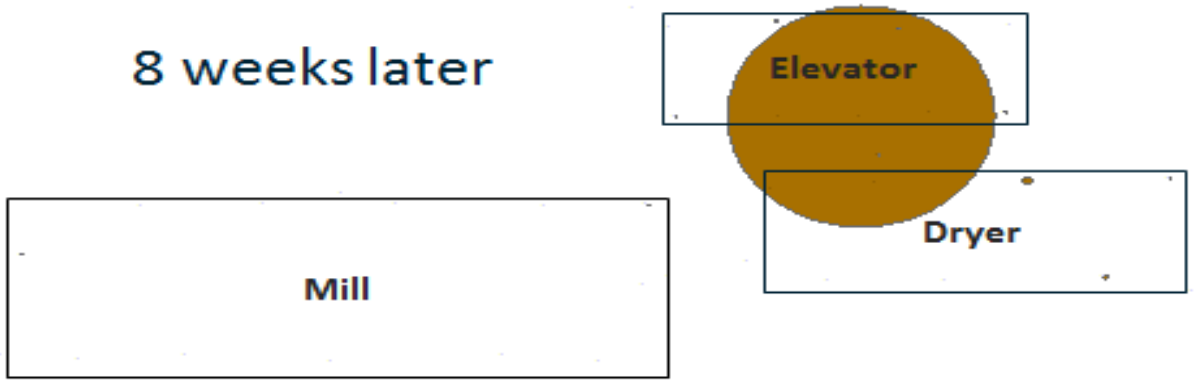


● : Size and color of yellow circle indicates insect population in that area of plant

Targeted treatments such as aerosols can control insects with lower cost using monitoring to identify trouble spots.


September 9
Elevator
Mill
Dryer
2 weeks later
Elevator
Mill
Dryer
4 weeks later
Elevator
Mill
Dryer
:
insec





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Targeted treatments may reduce:

- Control costs, by focusing efforts mostly on problem areas
- Expected insect damage loss, by focusing efforts on areas with potential for greatest economic loss

Work in progress:

- Using GIS to estimate spatial interactions across locations within processing plant
  - Targeted treatments in one area may affect insect # in other areas
  - Cost of insect # in some locations may be higher than others

Conclusion

- There is no one “most economical” choice for insect control – it depends on your situation
- Use the tools available to find ways to make insect control less costly and more effective

Thank you!

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